RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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RADIOLOGY

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Cellular Aspects of Tumor Therapy[1]

MORTIMER M. ELKIND, Ph.D.

A QUESTION which must often be considered when attempts are made to apply laboratory findings to medical problems is: Are the end-points used in the research problem directly applicable to the practical problem, and to what extent? Fortunately, research in the field of cellular radiobiology often can be directly applied to problems in radiation therapy because a criterion of effect commonly used by the cellular radiobiologist, *i.e.*, inhibition of proliferative ability, is also the end-point of concern to the therapist.

Although a considerable literature exists on the lethal effects of radiation on microorganisms, it has been only during the last few years that new tissue culture technics have afforded similar quantitative studies with mammalian cells. The early experiments of Rous and Jones (1), followed by the improvements of Puck *et al.* (2), permit, in essence, evaluation of the proliferative capacity of single cells as determined by ability to grow into visible colonies.

One of the principal problems in radiobiology is the question: Where and what, on a cellular level, are the sites of action of lethal irradiation. The proposal that these sites reside in the chromosomes (3) suggested to us that sublethal damage accumulated by surviving cells might be heritable. Investigation of this possibility led to the finding that none of the damage (within the resolution of our techniques) is inherited by the progeny of surviving cells (4). A surviving cell, therefore, can completely repair the sublethal events which it has experienced at the time of exposure. Our studies also showed that the repair of sublethal damage was completed before the first division post-irradiation.

In addition to the more basic aspects of our findings, which will be reported in detail elsewhere (5), the observation that mammalian cells which survive an acute exposure to x-rays rapidly undo their sublethal damage suggests an immediate application to radiation therapy. This stems from the fact that fractionated dosage schedules are commonly employed in which successive treatments are separated by at least a day. Our observations indicate that twenty-four hours is enough time for substantial if not complete recovery of surviving cells in culture.

When the recovery effects we have observed in culture are used for a theoretical analysis of tumor therapy, as will be developed later in this paper, it is found that the total dose required to reach a given survival level is predicted to increase rapidly with the number of treatments. This is in general agreement with the variation of tumoricidal doses with number of treatments observed in practice (6, 7). This in turn suggests that the relationship between total dose for a given survival and total number of treatments, the "isosurvi-

[1] From the National Cancer Institute, National Institutes of Health, Bethesda, Md. Presented at the Forty-fifth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 15–20, 1959

val" curve, is the same as the relationship between tumoricidal dose and total number of treatments, the "isoeffect" curve, thus reinforcing the view that radiotherapeutic effects can be evaluated on the basis of cell survival.

In addition to the derivation of iso-survival curves, the quantitative evaluations of cellular survival and recovery permit estimations of the effects of undertreatment for a given dosage schedule. In practice, undertreatment may result from an underestimation of the influence of recovery on the total dose required, or from an inability to complete a given treatment course due to patient response.

In those cases in which the principle of treatment to tolerance is employed, but without success even when a limited field is involved, it is reasonable to believe that the delivery of a larger total dose could have been successful. On the basis of survival criteria, it is not possible at this time to estimate quantitatively when the limit of tolerance will be reached in a given case. If it is assumed, however, that patient tolerance can be associated with lethal injury to normal tissue, then it is possible to show that significant insights on a relative basis with regard to different treatment courses can be obtained from survival criteria which duly account for cellular recovery.

The object of this paper is to develop such insights through the application of the results of tissue culture studies to the therapy problem. We shall present some survival curve theory; a brief description of our techniques; some of our data on the survival and recovery of cells irradiated *in vitro;* and finally, the application of our observations to therapy.

SURVIVAL CURVE THEORY

One of the unique features of the microbiological techniques that can now be employed with mammalian cells is that viability (*i.e.*, reproductive capacity) can be measured on a logarithmic scale. This results from the fact that high concentrations of viable cells (about 5×10^5/ml. are easy to prepare and that the viability of such cells is essentially independent of the number inoculated into a given dish. As a result, with mammalian cells, survival curves can be determined with facility over three or four decades. In contrast to this, clinical techniques currently available (*e.g.*, palpation, roentgenography, and histologic examination) are generally limited to measurement on a linear scale. This means that the estimation of tumor response to irradiation at the time of or shortly after treatment is limited to the 5 to 95 per cent range, which, as will be seen, is hardly adequate for purposes of estimating adequacy of treatment.

When good experimental techniques are brought to bear in systems measurable on a logarithmic scale, the resolution of the information obtained is essentially independent of the level of effect measured. That is, the statistical uncertainty in survival is about the same at survival levels of 0.1 per cent as it is at 100 per cent. This too is a significant feature inherent in well executed *in vitro* experiments but not present in *in vivo* determinations of survival.

A large range of measurement coupled with good resolution enables the cellular radiobiologist to seek quantitative confirmation of proposed models of the modes of action of radiation. One such model is the "multihit" or "multitarget" theory of the inactivation of a cell. Acccording to this theory, there is a finite and discrete number of independent sites in a cell, the integrity of any one of which is sufficient to insure the reproductive capacity of the cell. If there are n such sites, a cell is killed when all n sites are inactivated, and a cell will survive when $n-1$ or fewer sites have been inactivated. If, in addition, the inactivation of sites is random and one or more lethal events is sufficient to inactivate a site, then the probability of survival of any given site will be exponential. On the assumption that, on the average, all the sites have the same sensitivity, the probability of survival of the cell, S, is given by:

$$S = 1 - (1 - e^{-D/Do})^n \qquad (1)$$

where D is the absorbed dose, Do is the mean lethal dose (MLD) required to inactivate any given site, and n is the total number of sites.

Applying the binomial expansion to Equation 1, we have:

$$S = ne^{-D/Do} - \frac{n(n-1)}{2!}e^{-2D/Do} \cdots - \frac{(-1)^k n!e^{-kD/Do}}{(n-k)\,!k!} \cdots \quad (2)$$

As the dose D is increased, the second, third, etc., terms become very small compared to the first term, so that survival can be very closely approximated by

$$S \cong ne^{-D/Do} \quad (3)$$

Equation 3 contains in a clear way the two parameters that we will refer to in describing the general characteristics of a survival curve; the hitness number, n, and the MLD, Do. The equation shows that, in the large dose region, S is exponential, which means that one additional hit would have been sufficient to have killed a surviving cell. The extrapolation of the exponential curve (which plots as a straight line on semi-logarithmic co-ordinates) to zero dose intercepts the survival axis at n. This means that, for those survival curves which asymptotically approach a straight line on a semi-logarithmic plot, from the terminal portion of the curve, Do and n can be determined. Do is the increment in dose which lowers survival by a factor of $1/e$ ($\simeq 0.37$), and n is the zero dose intercept of the straight-line portion. Between unity survival (100 per cent survival) and the straight-line portion, a multihit survival curve has an increasing negative slope. This part of the curve constitutes the threshold region of survival. Thus, the hitness number is a measure of the width of the threshold region and the MLD is a measure of the slope of the exponential region. When $n = 1$, there is no threshold region.

All survival curves thus far determined by means of *in vitro* techniques appear to approximate closely the multihit form (*i.e.*, $n \geqslant 1$). Aside from the detailed interpretation of these curves, the feature which will be of importance in connection with recovery is that most mammalian survival curves have a threshold region followed by a straight line or exponential region.

While the ability to specify a survival curve by n and Do is quite valuable for semantic reasons, the interpretation of the results to be presented is not predicated on the validity of the multihit theory. All dose response curves which have a threshold region followed by a region of more rapid response for a given increment of dose have the following feature in common, namely, that damage must be accumulated before an effect is produced. In terms of the multihit theory, when the dose becomes large enough to reach the exponential region of survival, surviving cells have accumulated a maximum amount of damage or a maximum number of sublethal hits. Since exponential response means that one additional hit would have been sufficient to have killed a surviving cell in the exponential region, surviving cells have accumulated $n-1$ hits.

Although the terminology of the multihit model will be used, the only feature of mammalian cell survival curves which is critical to the interpretation of the observations to be described is that a threshold means that surviving cells had received sublethal damage. It follows that surviving cells whose response is entirely exponential ($n = 1$ and therefore no threshold region) do not accumulate any sublethal damage because only one hit is required to kill such cells.

MATERIALS AND METHODS

The major part of our work was performed with two established cell lines of the Chinese hamster, *Cricetulus griseus* (8). Clone *A*, ovarian tissue, was obtained from Dr. T. T. Puck, and from line *V*, female lung tissue obtained from Dr. Denys Ford (9), clone *V79–1* was established. Both cell lines have maintained a chromosomal constitution during these experiments close to the normal diploid karyotype.

Our growth medium is designated *HU-*

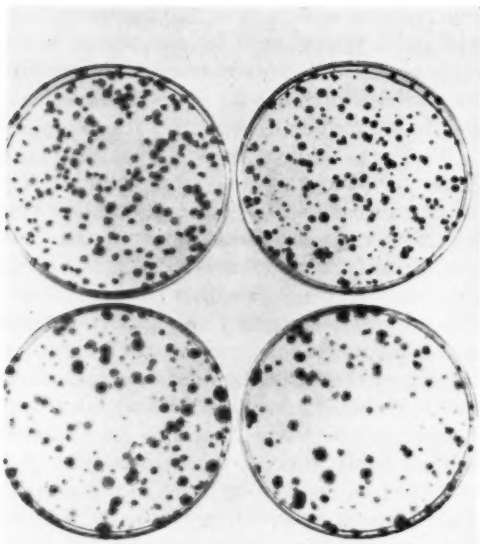

Fig. 1. Stained colonies of Chinese hamster cells, clone *V79-1*. Upper left, zero rad, twelve days incubation; upper right, 542 rad, fourteen days; lower plates, 1082 rad, sixteen days.

15. It consists of Eagle's amino acids and vitamins (10) with glutamine at 1 mM; Puck's saline *F* with the $CaCl_2 \cdot 2H_2O$ increased to 0.10 gm. per liter, plus antibiotics (11); 4 per cent of Earle's *NCTC*-109 (12); and 15 per cent fetal calf serum.[2] In *HU*-15, both cell lines grow with a doubling time of about twelve hours.

Our source of x-rays was a Machlett OEG-60 tube powered by a 55-kv Westinghouse full-wave rectified supply. In addition to the 1-mm. beryllium exit window of the tube, the beam was filtered by 0.175 mm. Al. With a beam current of 12.0 ma and the irradiation conditions to be described, the absorbed dose rate was 722 rad per minute. This latter value was obtained from an ionization current measurement corrected for absorption by medium and backscatter from the Petri dish and agrees within 12 per cent with the value determined with a chemical dosimeter (5).

The following is a typical experimental protocol. Cell suspensions were formed from sheets of cells grown on glass by trypsinization (5) and were serially diluted in *HU*-15. Control dishes (9 cm. in diameter) were inoculated with enough cells (about 300) to yield about 200 colonies, and dishes to be exposed were inoculated with larger numbers of cells depending on the number of survivors expected. The cells were then allowed to attach to the bottom of the dishes by placement for two hours in a 37° C. incubator in which a humidified atmosphere of 2 per cent CO_2 in air was maintained. Before exposure, the medium was removed from each dish in order to reduce the x-ray flux absorbed by the overlying medium to a few per cent. Each dish was exposed in a fixture (5) which permitted minimization of evaporation and *p*H variation during the exposure. After irradiation, each dish was re-fed appropriate aliquots of *HU*-15 and returned to the incubator. Control dishes were harvested after twelve days, and in general dishes containing the fewest numbers of surviving colonies were harvested after seventeen days. During the course of these experiments, plating efficiencies (percentage of cells plated on control dishes which grew into colonies) were between 55 and 75 per cent, although essentially the same results were obtained in experiments in which plating efficiencies varied from 10 to 90 per cent.

Figure 1 shows a group of dishes containing colonies stained with methylene blue. The upper left is a control dish. The cells in the upper right dish received 542 rad, those in the two lower dishes received twice that dose. The cells in the lower right dish received two equal doses separated by eight hours. As a result of longer incubation, some of the colonies in the irradiated dishes are larger than those in the control dish. The colonies, however, are fairly uniform in size in the latter case and in the former cases display a spectrum of sizes as typically found in other cellular systems. Each plate was examined through the use of a projection device (magnification 20×) to help distinguish abortive from surviving colonies. Standard errors in survival in-

[2] Obtained from the Colorado Serum Company, Denver, Colo.

creased somewhat with dose but were usually less than 10 per cent.

EXPERIMENTAL RESULTS

In Figure 2, the closed circles represent the survival of clone *A* cells. In this experiment, $n = 4.5$ and $Do = 128$ rad. To test for the repair of sublethal damage, the question was asked: How would the survival be affected if a given total dose was fractionated? That is, if a single dose of 992 rad reduces the survival to 0.0019, what would the survival be if the same total dose was delivered in two parts separated by varying lengths of time? The open squares, the recovery curve, show the result of such an experiment. The partial doses were 505 and 487 rad, respectively, and between doses the dishes were returned to the incubator for varying periods. The recovery curve shows that, with no apparent lag, the survival to the second dose, 487 rad, rises in an oscillating fashion and levels off at 0.0078. (The minimum in the recovery curve is much more apparent in other experiments.)

It is of interest to inquire whether or not the plateau at a surviving fraction of 0.0078 has any special significance. Unirradiated cells, in this case, required an average of 4.5 hits to be inactivated. Since the first dose, 505 rad, was just large enough to reduce survival to the exponential or straight-line region, cells which survived that dose received about 3.5 hits and 1 additional hit would have killed them. If these cells had completely repaired these hits before the second dose was delivered, they would have once again required 4.5 hits to be inactivated. Hence, full recovery between exposures would mean that survival to the second dose should be measured from the origin of the curve, just as survival to the first dose is measured. Therefore, the net surviving fraction corresponding to full recovery between exposures would be 0.082×0.095 or 0.0078. This agrees with the level of the plateau in the recovery curve, suggesting that the plateau represents full recovery between exposures.

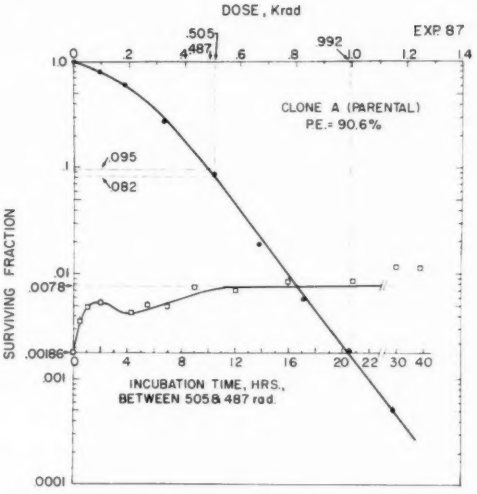

Fig. 2. Survival and recovery in Chinese hamster clone *A* cells (see text).

It should be noted that, after about twenty-five hours, the recovery curve begins to rise. By means of several independent methods (5), we have correlated this rise with the onset of division after the termination of post-irradiation division delay. The rise in survival results from the fact that, on the average, more than one cell must be inactivated per potential colony-forming unit. The recovery curve suggests, therefore, that surviving cells rapidly undo the damage they had accumulated, and that this process is completed before the onset of the first post-irradiation division.

To test that the plateau in Figure 2 indeed corresponds to the repair of sublethal hits, the experiment shown in Figure 3 was performed. The fractionated survival curve is shown by the closed circles; $n = 5.2$ in this case. After a first dose of 505 rad and 18.1 hours at 37° C. for repair of damage, the survival curve of cells surviving this first dose was determined. This is shown by the open circles; the points are plotted with the survival corresponding to 505 rad only as 100 per cent survival. The nonfractionated survival curve was redrawn from the second origin. It is clear that the redrawn curve is a very good fit to

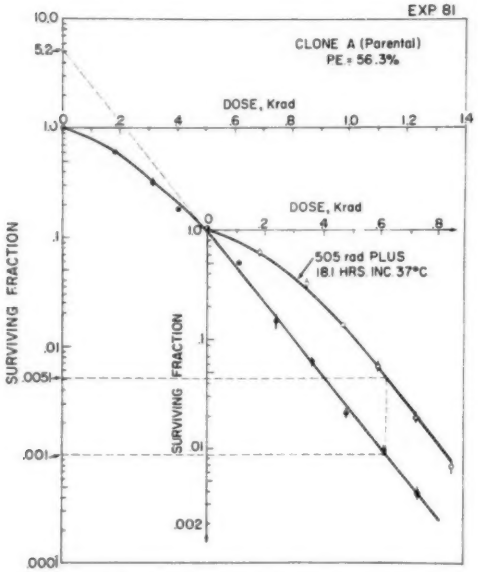

Fig. 3. Nonfractionated and fractionated survival curves, Chinese hamster clone A cells.

the data, which shows that cells surviving the first dose completely recovered. This in turn supports the view that the entire range of the plateau in Figure 2 corresponds to full recovery.

From Figure 3 it is also possible to deduce the magnitude of full recovery in terms of survival for first and second doses of different sizes. The first dose in Figure 3 was just about large enough to reach the exponential region of survival. The fractionated survival curve for this case shows that the ratio in survival resulting from two fractionated exposures and full recovery, compared to an equivalent single exposure, increases from 1 (zero second dose) to 5.1, which closely equals the hitness number. The ratio is a constant maximum when the second dose is large enough to reach the exponential region of survival on the fractionated survival curve. If the first dose is smaller, the ratio is always less than the hitness number but maximum for second doses large enough to reach the exponential region of survival. The ratio approaches 1 for all second doses, in the limit, as the first dose approaches zero, since then the two curves are superimposed.

It having been shown that surviving cells can fully recover after one acute exposure, the question arises: Can surviving cells undergo repeated cycles of damage and repair? An optimum experiment to test for this is shown diagrammatically in Figure 4. If A is the nonfractionated survival

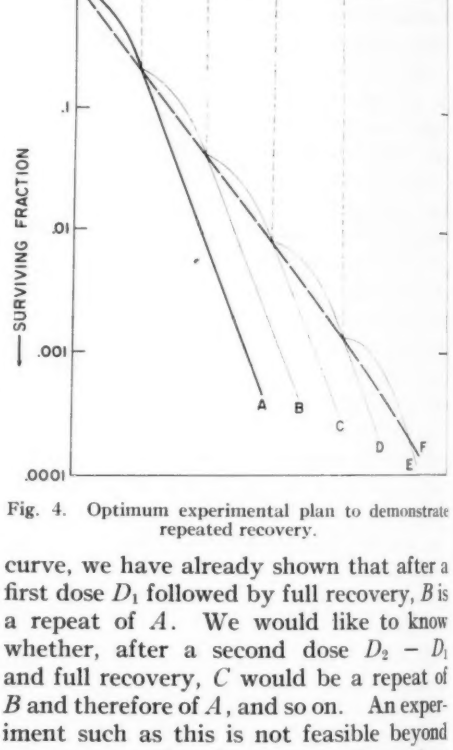

Fig. 4. Optimum experimental plan to demonstrate repeated recovery.

curve, we have already shown that after a first dose D_1 followed by full recovery, B is a repeat of A. We would like to know whether, after a second dose $D_2 - D_1$ and full recovery, C would be a repeat of B and therefore of A, and so on. An experiment such as this is not feasible beyond one or two cycles of recovery. A next best approach is to repeat only one point on the fractionated survival curve after each successive cycle of recovery. Curve F in Figure 4 shows that the theoretical survival which would result from equal exposures would appear to be exponential (as opposed to the inherent multihit character of the survival of these cells), providing recovery is complete before each successive exposure.

Figure 5 shows an experiment to test the predictions contained in Figure 4. The nonfractionated survival points are repre-

sented by closed circles. Two repeated exposure experiments were performed, with doses of 505 and 632 rad. In both instances, exposures were separated by twenty-two hours for recovery.

If the nonfractionated survival curve characterizes recovered cells after each cycle, then for each repeated exposure the survival should drop by a constant factor. For the 505 rad case, the predicted survivals are shown by the open squares and dashed curve. The closed squares and solid curve show the observed results. For the 632 rad case, the expected and observed results are superimposed. This experiment shows that, in all likelihood, surviving cells can undergo repeated cycles of recovery for up to at least four cycles. The experiment also indicates that division delays are probably additive.

In anticipation of the discussion to follow, it is instructive to note some of the quantitative aspects of the results in Figure 5. In a general way, this experiment illustrates the effects of fractionation on the survival of tumor cells. For instance, at a survival level of about 2×10^{-4} (0.02%), 1,500 rad is required if a single exposure is used, and 2600 rad if five exposures are used with recovery between exposures.

Alternatively, if the survival for the same total dose is compared, after five 505 rad exposures with recovery the survival is 1600 × higher than would be expected from the same total exposure delivered at one time. Even though the survival resulting from fractionation is three decades higher than without fractionation, the survival level produced corresponds to 2 cells in every 10,000 exposed. There are no known clinical technics which can detect such low levels of survival, to say nothing of lower levels.

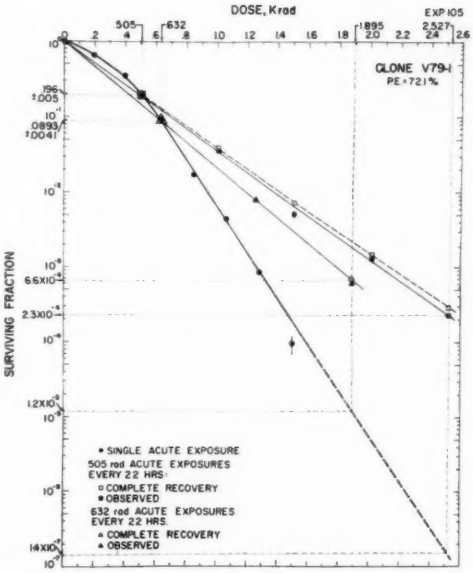

Fig. 5. Repeated recovery in Chinese hamster clone *V79-1* cells (see text).

DISCUSSION

The most direct way of illustrating the implications of cellular recovery in radiation therapy is to discuss these results in terms of an hypothetical problem. This will involve three sets of assumptions with regard to the response of malignant tissue, normal tissue, and the applicability of the data presented. So that the ground rules will be clearly defined, these assumptions will be listed.

I. Assumptions concerning the tumor size, properties, and response.

1. It will be assumed that we are to treat a tumor containing 10^9 cells. If the average cell diameter is about 20 microns, the tumor will be about 2.0 cm. in diameter.
2. With regard to radiation response, it will be assumed that the tumor consists of a homogeneous population of cells. It is recognized that in making this assumption we may appear to be ignoring pertinent effects involving stroma or the tumor bed. This is not necessarily the case as long as the malignant cells are the primary target of concern.
3. It will be assumed that the objective of therapy is to sterilize the tumor, and this comes about only after every malignant cell in the tumor is sterilized. Tumor response, therefore, represents the sum total expression of the response of the malignant cells populating the tumor.
4. To sterilize the tumor with a high probability of success, it will be assumed that a survival level of 10^{-11} must be reached. Since there are 10^9 cells in the tumor, this means that there is a 1 in 100 chance that a single cell,

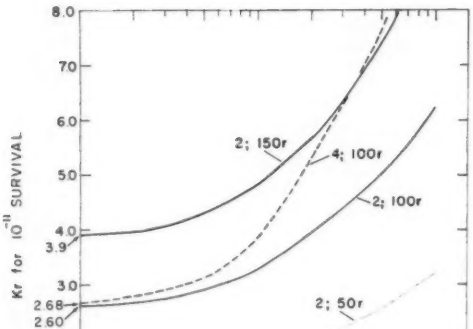

Fig. 6. Isosurvival curves plotted as a function of the number of treatments (see text).

and therefore the tumor as a whole, will survive.

5. It will be assumed that the general nature of lethality produced by x-rays and subsequent recovery is the same for malignant cells *in vivo* as it is for the cell lines studied in culture.

II. Assumptions concerning the response of normal tissue.

1. It will be assumed that "normal tissue" means any body tissues or fluids whose incidental irradiation during the course of treatment affects a patient in such a way that the limit of tolerance is reached and treatment must be terminated.
2. In an attempt to quantitate the normal tissue response, it will be assumed that its radiation response has the same general characteristics as that of malignant tissue and therefore the same as of the cells studied in culture. This means that the effects on normal tissue of incidental exposure will be evaluated on a survival basis. However, if the mechanism(s) that produces tolerance is not directly related to survival, as long as its quantitative aspects can be characterized by a hitness number (threshold) and a MLD (radiosensitivity), and as long as full recovery takes place between exposures, the analysis of the response of normal tissue will be qualitatively the same.

III. Assumptions with regard to the applicability of tissue-culture data.

1. It will be assumed that recovery is a general phenomenon which all surviving cells experience both *in vitro* and *in vivo* and to the same extent. This is a reiteration of I-4. Thus far the observations which were briefly described have been extended to only two sublines of HeLa cells by our associate, Dr. Royce Z. Lockart.
2. It will be assumed that the survival parameters determined from *in vitro* studies with suspensions of single cells (*i.e.*, hitness numbers and MLD's) apply equally to highly cellular tissue, such as solid tumors. That is, a cell in close proximity to its neighbors survives as an individual cell without experiencing coupling effects from other irradiated cells closely adjacent to it. To the extent that *in vitro* studies are indicative, we have found that, up to at least the 100 cell per clone stage, cells in an aggregate responded in the same way as single cells.
3. For practical reasons, *in vitro* studies with mammalian cells are limited to about the first four decades of survival. To apply such measurements to aggregates of 10^7 to 10^{10} cells, it is necessary to assume that the straight line portions of *in vitro* survival curves can be extrapolated three to six decades. While evidence is not available at this time to justify this assumption, we know of no evidence which indicates it is *not* justified.

With respect to assumption I-2 a few additional remarks are in order. As a fractionated treatment protocol progresses, it is reasonable to expect that the vascular supply and supportive tissue of the tumor may be disrupted. Aside from structural effects, this may produce a state of anaerobiosis and/or the nutrition of the tumor cells may be upset. In addition, dissimilation products or the products released by lysing cells may be toxic to surviving cells. Anaerobiosis generally produces a decrease in sensitivity, while malnutrition and toxic products in effect increase sensitivity. The preceding may have concomitant effects on recovery as well as lethality. Hence, it is difficult to predict in what direction, if at all, the cellular response of the tumor will be altered. However, as long as these presently indeterminate factors have only a quantitative influence, the general picture of the effects of fractionation, to be developed, will not be altered.

Figure 6 shows a set of isosurvival plots to which the preceding assumptions lead. The dose required to reach 10^{-11} survival is plotted against the number of treatments, N, with the proviso that the doses per treatment are equal. Labels such as "2; 50 r" mean that the cells of a particular

tumor respond with a hitness number of 2 and a MLD of 50 r.

For "1; 50 r" cells, the single exposure dose is 1,300 r and constant. A hitness number of 1 means exponential survival, and our experimental results imply that there is no recovery and therefore the dose for 10^{-11} survival is constant.

If cells of the same sensitivity have a hitness number of 2, the isosurvival curve increases with N. The curves "2; 100 r" and "2; 150 r" show the effect of decreasing sensitivity (larger MLD's) on the doses required to reach 10^{-11} survival.

Of particular interest is the curve "4; 100 r," which is to be compared with "2; 100 r." While for small N's the total doses for these two cases are about the same, from about $N = 10$ on the two curves diverge rapidly.

Figure 6 shows the following essential points: (*a*) If the hitness number is 1, the isosurvival dose is constant. (*b*) For hitness numbers greater than 1, the doses for a given survival increase with the number of treatments. (*c*) For a given hitness number, *e.g.* $n = 2$, as the MLD is increased the curves are displaced upward. (*d*) For a given MLD, increasing the hitness number causes the curves to rise much more steeply. (*e*) Relatively small absolute changes in survival curve parameters are capable of predicting tumoricidal doses within the range commonly used in practice (6, 7). This last point is important. The initial observation by Puck and Marcus (3) that the MLD of at least one mammalian cell line in culture (HeLa) was about 100 r prompted some therapists to point out that this value was too low to explain the relatively large doses needed for many tumors. Figure 6 shows that when recovery is accounted for, this criticism is not justified.

There are three general points that should be noted with respect to Figure 6. The first concerns the shape of the survival curves assumed for computing the isosurvival curves shown. For numbers of treatments greater than about 10, the isosurvival dose becomes significantly dependent upon the shape of the survival curve in the threshold region. In plotting Figure 6. it was assumed that the survival curves were of the multihit form; that is, that their initial slopes were zero. While the HeLa cell survival curve previously published (3) displayed a zero initial slope, we have found that Chinese hamster cells yield survival curves with a small negative initial slope (5). For the same values of n and MLD, the effect of a negative initial slope would be to cause the isosurvival curve to rise less rapidly than the corresponding curve shown in Figure 6.

The second point concerns tumor size. For about a factor of 8 increase or decrease in the number of cells (plus or minus about a factor of 2 in tumor diameter), the dose for one treatment would be shifted by plus or minus 2 MLD's respectively. As the number of treatments is increased, the effect on the isosurvival dose would be larger but would still amount to only a few MLD's. Hence, the isosurvival curves are only weakly dependent on tumor size.

The third point concerns the co-ordinates used in Figure 6. On a semi-log plot, as shown, isosurvival curves which reflect recovery are concave upward. On a log-log plot, these curves would appear as ascending, almost straight lines, and on a linear plot, the curves would appear concave downward. In the radiation therapy literature (6, 7) different authors have used different co-ordinates in plotting isoeffect curves. This point is mentioned in order to avoid confusion which might result from the shape of the curves alone.

In general, isosurvival curves are not available to the therapist. In view of this, it is relevant to inquire what will be the effect on survival if an insufficient total dose is delivered with a given fractionation protocol. This situation might come about either because a therapist is not attempting to treat to tolerance, or because the limit of tolerance is reached before the treatment course is completed. Figure 7 shows the results of undertreatment for three specific cases.

With the understanding that a survival of 10^{-11} is needed to sterilize the tumor,

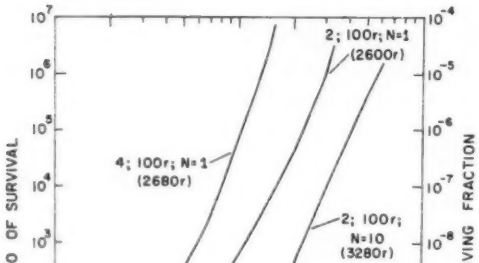

Fig. 7. Effects of undertreatment on survival (see text).

the right ordinate shows the actual survival obtained and the left ordinate shows the ratio of the actual to the required survival. The curve "4; 100 r; $N = 1$" is for the "4; 100 r" tumor in Figure 6, which requires 2,680 r for $N = 1$. If 2,680 r is spread equally over a larger number of treatments, the curve shows the effect on survival predicted by recovery between exposures. The curve "2; 100 r; $N = 1$" rises less steeply because the isosurvival curve in Figure 6 for "2; 100 r" rises less steeply. The results of spreading the correct dose for ten treatments over more than ten treatments is shown by the curve "2; 100 r; $N = 10$".

In effect, Figure 7 shows that if the tumoricidal dose is underestimated for a given tumor and a given schedule, even if the total dose is delivered, a survival level may be reached which is several factors of 10 higher than required. Once again, it should be pointed out that current clinical methods which can be applied at the time of treatment or shortly thereafter are not capable of determining when a tumor has been undertreated.

Figures 6 and 7 are concerned only with the tumor. In principle, irrespective of what particular isosurvival curve might apply and irrespective of the dose per treatment in a given case, if a large enough total number of treatments can be administered, the disease should be cured unless some new phenomena are incurred (*e.g.*, radiation tumorigenesis or the induction of metastases due to the liberation of viable cells

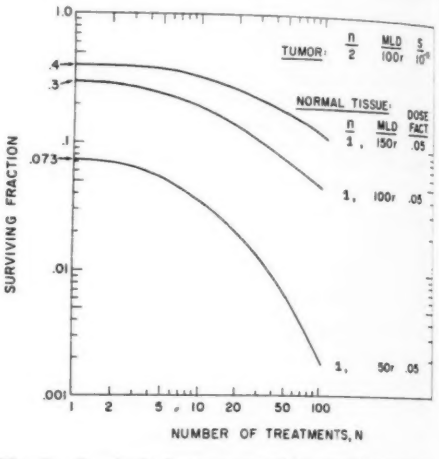

Fig. 8. Survival of nonrecoverable normal tissue as a function of number of treatments (see text).

from the site under treatment). This is the major thought underlying the principle of treatment to tolerance. It is therefore important to inquire what some of the factors might be that produce a tolerance level before a large enough total dose has been absorbed by the tumor.

As stated at the outset, in discussing the effects on normal tissue which result from its incidental irradiation, it will be assumed that these tissues recover and the analysis will be based on survival criteria. Clearly, it is not possible at this time to correlate the survival of so-called "normal tissue" with so-called "tolerance." Nevertheless, it will be shown that some insights of a relative nature can be obtained, the reasonableness of which support the plausibility that an analysis on this basis may be valid.

The analysis will consist of three parts. First, for a given tumor, "2; 100 r" in Figure 6, which requires a survival of 10^{-11}, we will consider the influence of the normal tissue MLD with and without recovery. Second, for the same tumor, we will consider the influence of the relative amount of

exposure that the normal tissue receives. And third, for an assumed normal tissue response with recovery, we will consider the effect on the latter of treating different tumors to a survival level of 10^{-11}.

In Figure 8, the surviving fraction of normal tissue is plotted as a function of the number of treatments. The tumor parameters assumed are "2; 100 r; 10^{-11}" (see Fig. 6). On the assumption that only 5 per cent of the tumor dose is absorbed by normal tissue, the three curves show the effect on survival of MLD's of 50 r, 100 r, and 150 r. In each case, the hitness number is 1 (no recovery in the normal tissue between treatments). While the more sensitive the normal tissue, the lower the starting survival level, the curves clearly show that if there is no recovery between treatments there is no advantage to be gained from fractionation.

Taking the worst case in Figure 8, normal tissue "1; 50 r; 0.05 dose factor," Figure 9 shows the influence of recovery. To facilitate comparisons, this latter curve is reproduced as a dashed line. When even a small amount of recovery is introduced, normal tissue "1.5, 50 r, 0.05 dose factor," not only does the curve not descend, but a net increase in survival of about 3 × can be obtained *via* extended fractionation.[3] The curve labeled "1.5, 50 r, 0.1 dose factor" shows the negative influence of poor localization. The importance of optimum beam directing techniques is well recognized. The latter curve shows that an increase in the total dose to the normal tissue by a factor of 2 does not eliminate the relative advantage to be gained from fractionation. However, the absolute amount of damage to normal tissue is increased, and the magnitude of the relative benefit is less.

We now consider the influence of different tumors all for the same normal tissue response. Once again to facilitate comparisons, the best normal tissue curve in Figure 9, "1.5, 50 r, 0.05 dose factor," is

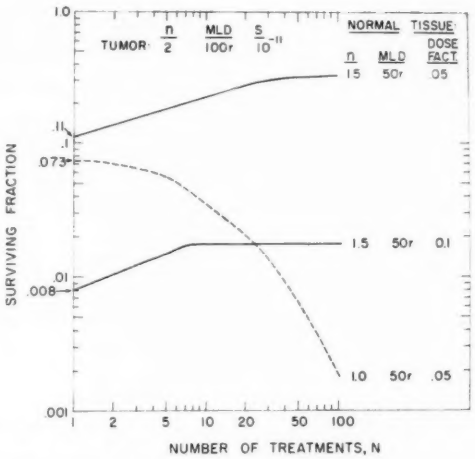

Fig. 9. Survival of recoverable normal tissue as a function of number of treatments (see text).

reproduced in Figure 10 as a dashed line. This latter curve was for the tumor parameters "2, 100 r, 10^{-11} survival." If the tumor MLD is increased by 50 per cent, curve "2, 150 r, 10^{-11} survival," the effect on normal tissue is increased. As in the case of poorer dose localization, both the absolute and relative benefits of fractionation are reduced. If, however, the tumor MLD is the same, but the hitness number is increased from 2 to 4, a new effect becomes apparent. Although the initial part of the curve is close to the "2, 100 r, 10^{-11}" curve, which shows that normal tissue does recover, a maximum is reached which is followed by a fairly rapid descent. This shows that there may be tumors the successful treatment of which will incur increasing damage to normal tissue if the number of treatments is increased beyond a certain point. Hence, the three curves in Figure 10 show that the limit of tolerance may be reached before a tumoricidal dose is delivered, because the tumor is too insensitive, because the threshold region of the tumor cell survival curve is too broad, or because both conditions are true.

It is worth reiterating that the actual survivals shown in Figures 8, 9, and 10 cannot be correlated quantitatively with damage to normal tissue. In spite of this, the

[3] It is of interest to note that Puck *et al.* (13) have reported the following survival parameters for a cell line derived from normal skin: n = 1 to 2; MLD = 50 to 70 r.

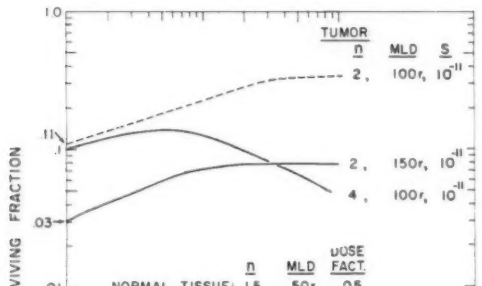

Fig. 10. Survival of recoverable normal tissue as influenced by tumor survival parameters plotted as a function of number of treatments (see text).

main points that emerge from a relative analysis are: (*a*) fractionation is beneficial if recovery takes place in normal tissues as well as in the tumor; (*b*) optimum dose localization is essential; (*c*) there may be tumors which cannot be sterilized, either because the net amount of damage to normal tissue is too large, even though it decreases as the number of treatments is increased, or because the amount of damage increases with the number of treatments beyond a certain point.

CONCLUSIONS

The recovery of sublethally irradiated cells is a new observation which has important implications in connection with radiation therapy. In discussing these implications, admittedly a number of assumptions were made which will have to be tested by future work. The radiation response of malignant and normal tissue is a complicated matter which may involve a number of basic phenomena in addition to the one described. However, there now exists a framework which, it is believed, will serve the twofold purpose of aiding the analysis of tissue recovery through research with mammalian cells grown in culture as well as indicating some of the promising directions research in radiation therapy should take.

Cellular recovery may not answer all questions pertaining to tissue recovery. Still, the effects predicted are sufficiently large to suggest that it is one of the major mechanisms involved. When the limits of applicability of cellular response have been determined, it should then be possible to recognize other mechanisms that may be pertinent and to study them with increased resolution.

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SUMMARIO IN INTERLINGUA

Aspectos Cellular del Therapia de Tumores

Le restablimento de subletalmente irradiate cellulas mammalian es un nove observation de importantia per su applicationes al therapia radiational. Duo establite lineas de cellulas ab le hamster chinese. Esseva cultivate in vitro e subjicite a varie doses de irradiation. Le facto del restablimento de cellulas, demonstrate per iste experimentos, es discutite in su signification pro le irradiation therapeutic de tumores maligne, con certe presuppositiones que ha a facer con le tumor mesme, con le responsa de tissus normal, e con le applicabilitate de datos histocultural a situationes in vivo.

Durante que le responsa radiational de tissu normal e maligne es un cosa de alte grados de complexitate in que un pluralitate de phenomenos fundamental es possibilemente interessate, le conclusion es presentate que le restablimento cellular es un del major mechanismos participante in ille complexo.

Inter le punctos signalate, le sequentes pote esser mentionate: Le fractionation del tractamento es benefic si le restablimento occurre in tissu normal si ben como in le tumor. Un localisation optimal del dosage es essential. Certe tumores non pote esser sterilisate (1) proque le quantitate nette del lesiones in tissu normal es excessive—mesmo si illo se reduce con le crescentia del numero de tractamentos—o (2) proque le quantitate del lesiones cresce con le numero del tractamentos in ultra de un certe puncto.

Pulmonary Veins in Rheumatic Heart Disease[1]

ROBERT S. ORMOND, M.D., and ANDREW K. POZNANSKI, M.D.

IN THE CURRENT era of advances in cardiac surgery there is constant stimulation to increase our knowledge of cardiopulmonary physiology and further the contribution of radiology to evaluation of the cardiac patient. The changes produced in the lung fields by rheumatic valvular heart disease have been appreciated by the roentgenologist for years and have been recently summarized by Kerley. The pulmonary arteries have been studied intensively by Whitaker and Lodge in England and Jacobson, Schwartz, and Sussman, and others, in America. The pulmonary veins have received less attention. De Bettencourt, Saldanha, and Fragoso found them decreased in size as left atrial pressure increased. These workers observed no dilatation of the veins in mitral valvular disease and reported small veins in the presence of auricular fibrillation. As enlargement of the left atrium increased, they observed displacement and distortion of the veins and were unable to demonstrate them at all in the presence of giant left atria. Steinbach, Keats, and Sheline described the veins as of normal size or smaller in mitral valvular disease. Simon observed a decrease in both lower lobe and upper lobe veins in patients with high pulmonary wedge pressure in mitral stenosis, and Kerley believed that a distinction existed in the appearance of the venous vasculature in mitral stenosis and mitral insufficiency.

The present study is confined to evaluation of the pulmonary venous changes in rheumatic valvular heart disease. The findings are not entirely in agreement with those of previous investigators.

We have found that the appearance of the pulmonary veins on the postero-anterior film reflects pressure changes in the left atrium. There is a definite correlation between the size of the pulmonary veins and left atrial pressure. The upper lobe veins increase in size as the pressure rises. Spasm in these structures has not been observed. Changes in the lower lobe veins are less constant. Here there is an increase in the size of the veins as the pressure rises to 15 or 16 mm. of mercury, followed by an apparent gradual decrease in the absence of failure. In many patients, however, with elevated pressure, enlargement of the lower lobe veins persists. In the presence of failure the veins tend to be large.

Fig. 1. Pulmonary veins in right lung field. s. Posterior division of the superior pulmonary vein. m. Vein to the middle lobe. sb and ib. Superior basilar and inferior basilar divisions of the inferior pulmonary vein. A. Left atrium.

From the appearance of the pulmonary veins an accurate estimate of the left atrial pressure can be made. It is possible to divide the patients into three basic pressure groups. The low group, with pressures up

[1] From the Department of Radiology, The Henry Ford Hospital, Detroit, Mich. Presented at the Forty-fifth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 15–20, 1959.

to 15 mm. of mercury; the intermediate group, with pressure of 15 to 22 mm. of mercury; and the high group, above 22 mm. of mercury. We have found no difference in the appearance of the pulmonary veins among the various rheumatic valvular lesions.

The anatomy of the pulmonary veins has been thoroughly studied by Boyden and reviewed by Michelson and Salik. Figure 1 is a diagram of the pulmonary veins in the right lung field. There is some variation in their position and distribution. In the right upper lung field, however, the posterior division of the right superior pulmonary vein is a fairly constant structure and can be identified as it crosses the right upper lobe bronchus; it lies parallel to the right apical segmental bronchus and lateral to the apical branches of the right pulmonary artery. In the right lower lung field the inferior pulmonary vein has two contributing divisions—the inferior and superior basilar. The upper and lower lobe veins ordinarily can be located on plain postero-anterior films. They can be separated from the arterial structures by following their course to the left atrium, and are seen to cross the branches of the pulmonary arteries.

MATERIAL

The postero-anterior films of 172 patients who had undergone cardiac catheterization were examined for the appearance of the pulmonary venous vasculature. In 107 patients percutaneous left atrial heart catheterization was done and routine upright inspiratory postero-anterior films were taken within forty-eight hours thereafter. Sixty of this group were subsequently operated upon for correction of valvular defects. In a second group of 65 patients, there were obtained, in addition, laminagrams of the right pulmonary vasculature in the upright position, within the same period. Of these patients, 50 had percutaneous left atrial catheterizations and 25 had right heart catheterization by way of the brachial vein. Seventeen patients of this group had subsequent cardiac surgery. The postero-anterior films were made at 120 kv at 6 feet with Bucky grid.

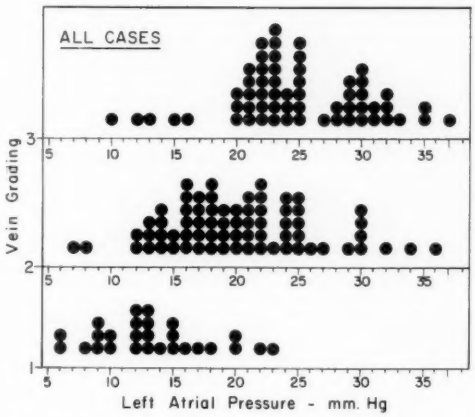

Fig. 2. Plot of upper lobe vein size against left atrial pressure in all cases. Each dot represents a patient.

TABLE I: DISTRIBUTION OF VALVULAR LESIONS IN THE TWO GROUPS STUDIED

	Group 1	Group 2
Total number of patients in each group	107	65
Mitral stenosis, pure	22	17
Mitral stenosis, predominant	19	6
Mitral insufficiency, pure	18	12
Mitral insufficiency, predominant	24	4
Aortic lesion	17	17
Mixed mitral and aortic lesion	7	9
Operated	60	17

The valvular lesions in the two groups are summarized in Table I. In those cases neither confirmed by direct palpation nor inspection of the diseased valve, the final clinical impression based upon catheter studies, physical examination, electrocardiograms, and x-ray appearance of the heart has been accepted. A mitral lesion is classified as pure when it was so evaluated by catheter study and when, at operation, the surgeon observed, at most, a minimal or insignificant degree of the opposite type of lesion. Aortic lesions include stenotic and insufficient valves; aortic lesions in which there was accompanying mitral insufficiency secondary to left ventricular failure are included in this group.

THE UPPER LOBE VEINS

Postero-anterior films of the chest ob-

tained within forty-eight hours of percutaneous left atrial catheterization studies were examined without knowledge of the catheterization findings. The upper lobe veins were classified according to size. Originally the division was made on a basis of 0 to 4 scale. However, because of considerable diversity of opinion and inconsistencies of individual examiners on different occasions, a simpler classification, based upon a 1 to 3 scale, was adopted. Group 1 includes the normal to slightly prominent venous channels; Group 2 the moderately enlarged veins; Group 3 the markedly distended channels. Figure 2 is a plot of the three groups against the left atrial pressure.

The patients with the largest veins have pressures above 20 mm. of mercury. The intermediate vein group falls between 15 and 25 mm. of mercury. In the patients with the smallest veins, the pressures are below 15 mm.

When the lesions are divided into pure groups (Fig. 3), no difference is apparent between mitral stenosis and mitral insufficiency or between aortic lesions and mitral lesions. Figures 4 to 7 show examples of the upper lobe veins in each of the groups:

Figure 4 is an example of the upper lobe veins classified in Group 1. The patient was a 45-year-old female with a left atrial pressure of 16 mm. of mercury. At commissurotomy the valve was found to be tightly stenosed. There was minimal regurgitation.

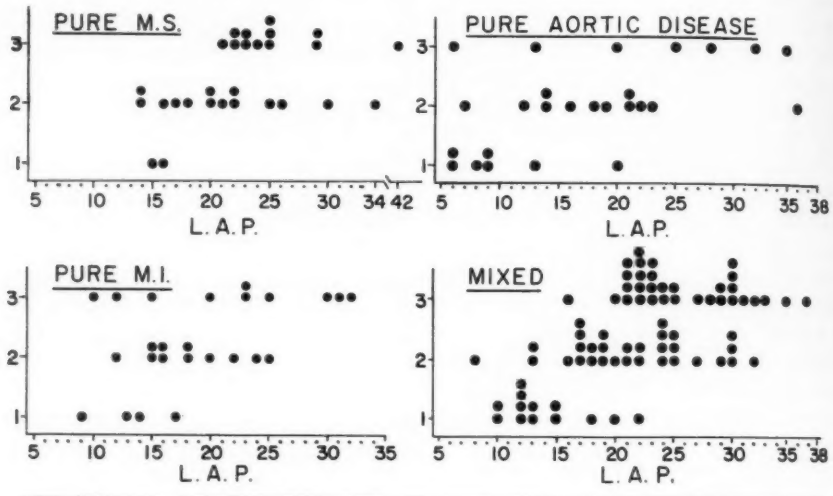

Fig. 3. Plot of upper lobe vein size against left atrial pressure in each of the valvular lesions.

Figure 5 illustrates the upper lobe veins in Group 2. The patient was a 52-year-old male without regurgitation at mitral commissurotomy. The left atrial pressure was 20 mm. of mercury.

Figures 6 and 7 are examples of upper lobe veins in Group 3. Figure 6 is the film of a 49-year-old male with mitral stenosis and only minimal insufficiency as seen at commissurotomy. The left atrial pressure was 29 mm. of mercury.

Figure 7 shows the chest of a 56-year-old female with mitral insufficiency with mild left ventricular failure. The diagnosis of failure in this case is based upon the finding of an elevated left ventricular end diastolic pressure on catheterization studies. The left atrial pressure was 23 mm. of mercury.

LOWER LOBE VEINS

The study of the lower lobe veins was limited to the second group of patients, on whom upright laminagrams of the right

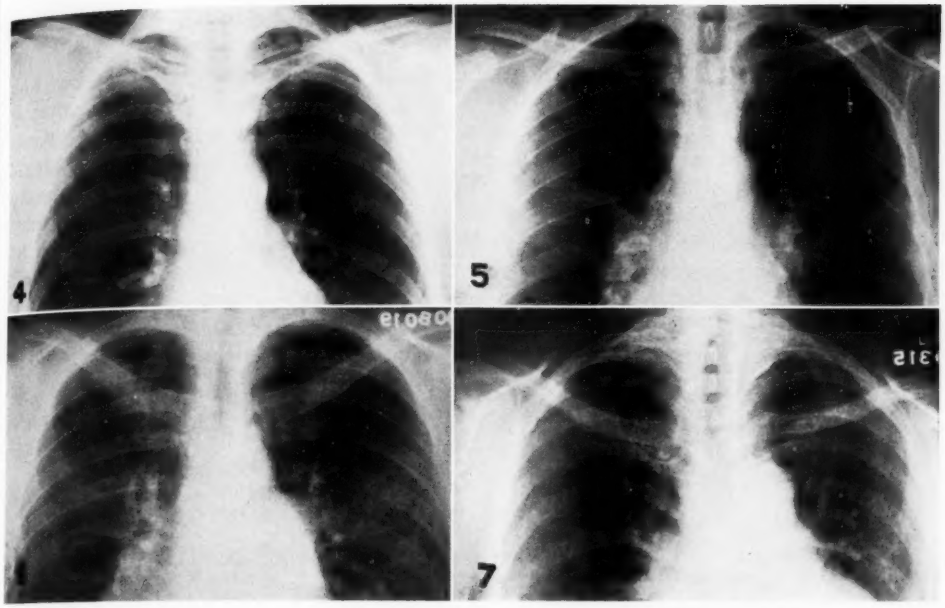

Fig. 4. Example of upper lobe veins classified as Group 1. Left atrial pressure 16 mm. mercury.
Fig. 5. Example of upper lobe veins classified as Group 2. Left atrial pressure 20 mm. mercury.
Fig. 6. Example of upper lobe veins classified as Group 3. Left atrial pressure 29 mm. mercury.
Fig. 7. Example of upper lobe veins classified as Group 3. Left atrial pressure 23 mm. mercury. Failure present.

lower lung field were obtained. The examination was made in inspiration, with the aid of an immobilization band. The exposure time was two seconds. In a few cases expiration films were obtained as well as prolonged inspiration films. There was little appreciable difference in the appearance of the veins in the few cases thus examined.

The anatomy of the venous channels in the lower lung field is subject to some variation. The superior basilar division of the inferior pulmonary vein (Boyden) was selected for study. It is a fairly constant structure, lying nearly horizontal and, therefore, perpendicular to the vertical travel of the tube shift and theoretically should be more sharply defined than veins in a more vertical position.

Two points on the vein were selected for measurement. Point 1 is approximately 1 cm. proximal to the left atrium and just distal to the first division of the vein. Point 2 lies in the peripheral lung field just proximal to the last major division of the vein and distal to the terminal branches. The sum of these two measurements was plotted against the left atrial pressure in each of the valvular lesions (Fig. 8).

The plot of the points suggests a gradual increase in vein size to a maximum when the left atrial pressure is 17 mm. of mercury. With pressures above this level, the distribution is somewhat more scattered. We hesitate to draw a composite line to graph the results.

Measurements of other points in the veins were plotted with no significant difference in appearance of the graph. Body heights and weights of the patients were correlated with vein size, but again there was no change in the appearance of the curve. Vein size was also judged on a subjective basis from the laminagrams on a 1 to 3 scale. Patients in failure tended to have large veins, while those with high pressure, but not in failure, were about equally divided among the three groups.

Figures 9 and 10 show examples of the lower lobe veins at various pressure levels.

Laminagrams are included as they better delineate the veins but, when looked for, these are readily apparent on the plain films.

Figure 9, A is the postero-anterior chest film of a 27-year-old female with mitral stenosis. The upper lobe veins were classified in Group 1. Pulmonary wedge pressure was 14 mm. of mercury. Figure 9, B is the laminagram of the lower lobe veins. These are large and, indeed, fall into the group with the largest veins, *i.e.*, about 15 mm. of mercury.

left atrial pressure. In patients in whom there are greatly enlarged left atria, the veins are almost without exception tiny; only the peripheral portions are visible. The appearance suggests incorporation of the central portion into the left atrium. An explanation for this may be the observation of Burch and Romney, who on anatomical dissection, described a sleeve of left atrial muscle extending into the proximal portion of the veins. The vein may be an extension of the atrium in this location. In the peripheral portion of the lung field the

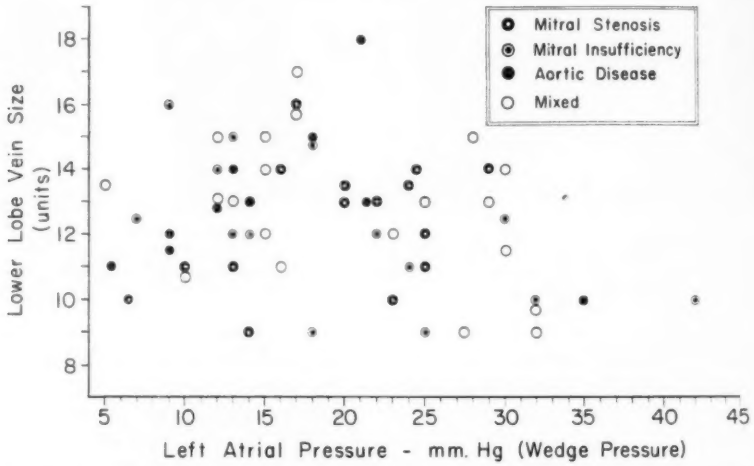

Fig. 8. Plot of left atrial pressure or pulmonary wedge pressure against measurement of superior basilar vein on upright laminagrams. Each symbol represents a patient

Figure 10, A is the postero-anterior film of a 30-year-old female with mitral stenosis with a pulmonary wedge pressure of 24 mm. of mercury. The upper lobe veins were classified in Group 2. Interseptal B lines of Kerley are visible. The patient was not clinically in failure. The lower lobe veins are readily apparent on the film. The laminagram of these veins is reproduced in Figure 10, B. The veins are seen to be of generous size. There is no evidence of spasm.

The distinctness of the lower lobe veins decreases as the pressure becomes elevated. The loss of definition may be a manifestation of interstitial fluid, and should be considered in arriving at an estimate of veins are no smaller than those in the same location in other cases at the same pressure levels with small left atria.

HIGH VENOUS PRESSURE

There were 47 patients with left atrial pressures of 25 mm. of mercury or above. In only 7 cases did the upper lobe veins not appear markedly enlarged and in only 2 cases did the appearance suggest a very much lower pressure. Figures 11 and 12 are examples of markedly elevated left atrial pressures.

Figure 11 shows the case of a 53-year-old male with combined aortic stenosis and mitral stenosis. The left atrial pressure was 29 mm. of mercury. The upper lobe

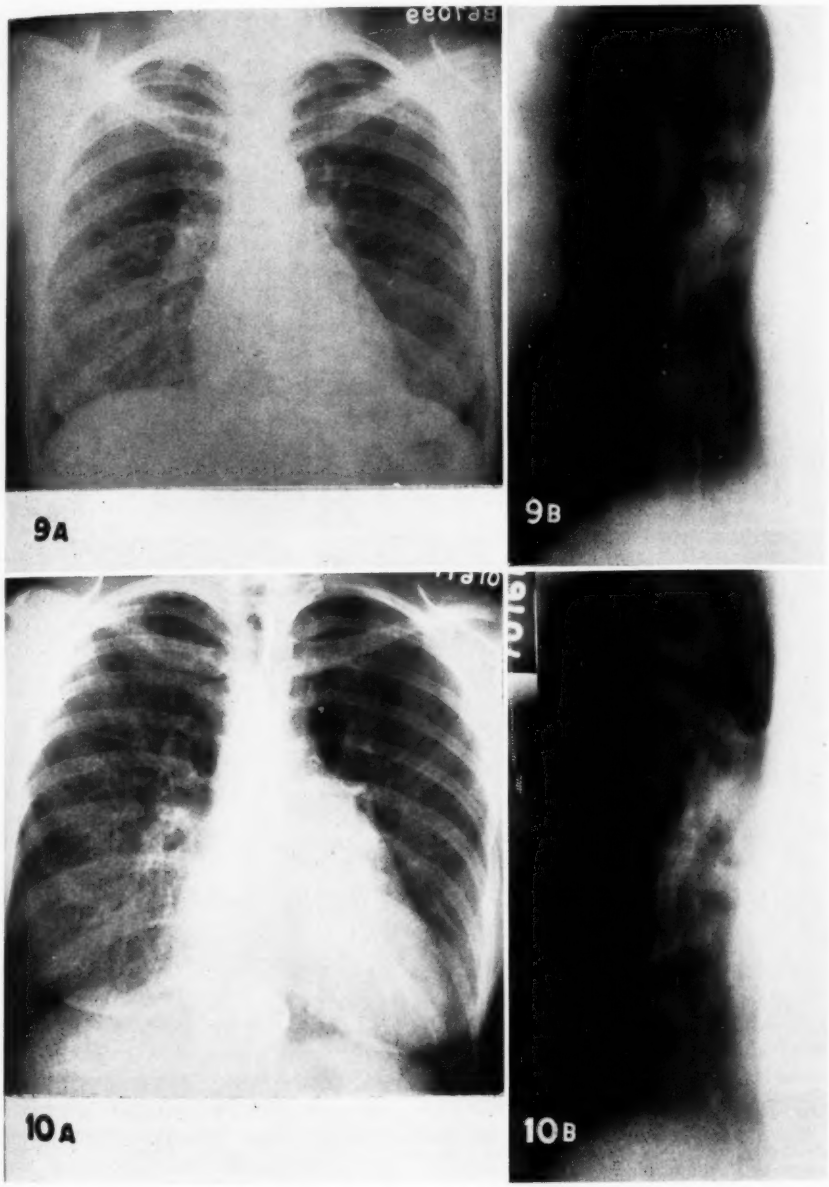

Fig. 9. Postero-anterior film (A) and laminagram (B) of patient with mitral stenosis. Pulmonary wedge pressure 14 mm. mercury. Upper lobe veins classified as Group 1. Lower lobe veins large.

Fig. 10. Postero-anterior film (A) and laminagram (B) of patient with mitral stenosis. Pulmonary wedge pressure 24 mm. mercury. Upper lobe veins classified as Group 2. Lower lobe veins prominent.

veins were classified in Group 3. There was no clinical evidence of failure, nor was failure evident on catheterization study. There were thought to be basilar lymphatics on the plain films. In the laminagram (B) the lower lobe veins are only

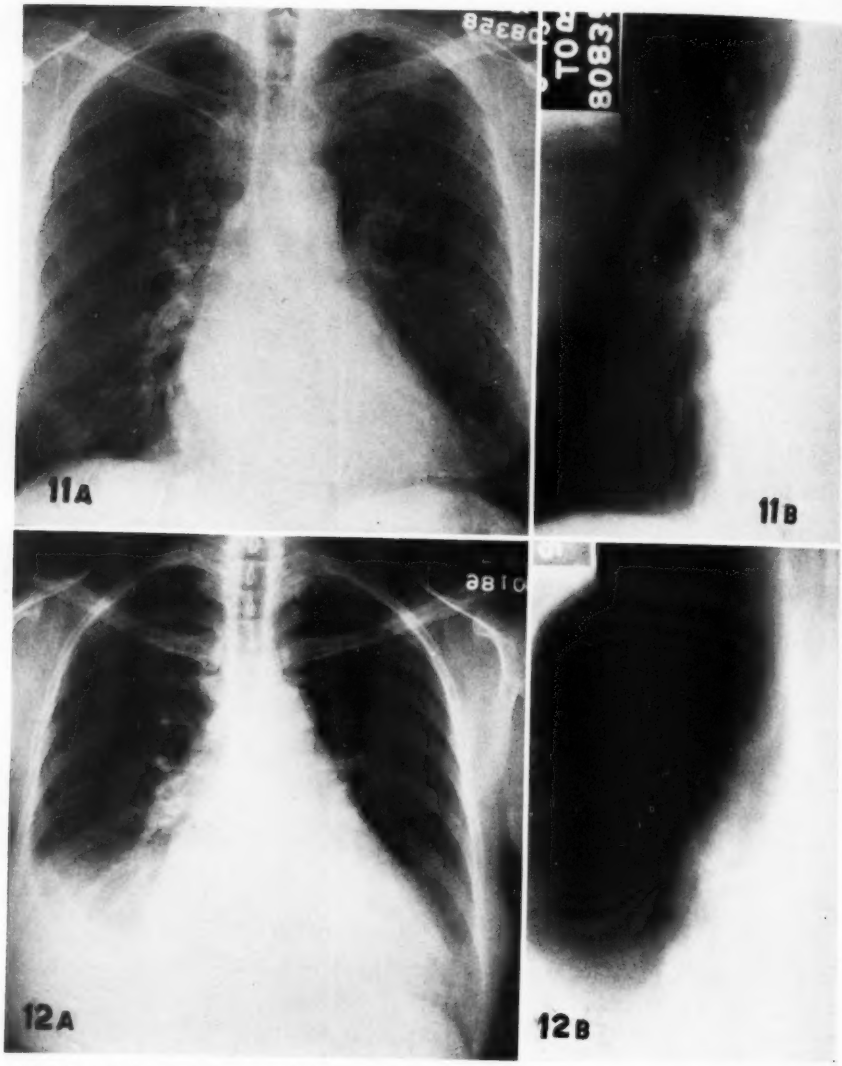

Fig. 11. Postero-anterior film (A) and laminagram (B) of patient with aortic stenosis and mitral stenosis. Left atrial pressure 29 mm. mercury. Upper lobe veins classified in Group 3. Lower lobe veins prominent.

Fig. 12. Postero-anterior film (A) and laminagram (B) of patient with aortic stenosis. Left atrial pressure 28 mm. mercury. Upper lobe veins classified in Group 3. Lower lobe veins obscured by fluid but large.

slightly less prominent than in patients with low pressures.

Figure 12 is from a 46-year-old female with aortic stenosis with left ventricular failure, relative mitral insufficiency, and roentgen evidence of frank failure. The left atrial pressure was 28 mm. of mercury. The upper lobe veins are classified in Group 3. The lower lobe veins are noted to be indistinct, but appear large on the laminagram (B).

CONCLUSION

1. Pulmonary vein size is related to pressure within the left atrium. An accurate estimate of the left atrial pressure can be

obtained from plain postero-anterior films of the chest.

2. Upper lobe veins are a more reliable index to elevated pressure than lower lobe veins. However, the size of the lower lobe veins should be considered, as well as presence of Kerley's B lines, fluid, and distinctness of the veins.

3. No appreciable difference in appearance among lesions producing an elevated pressure has been observed.

4. With increasing pressures there is an increase in size of the upper lobe veins.

5. The veins in the lower lobes are disproportionately enlarged in the presence of congestive failure.

NOTE: The authors are indebted to Dr. Ellet Drake, of the Adult Cardiology Department of the Henry Ford Hospital, for his aid in interpreting and making available the catheterization data.

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SUMMARIO IN INTERLINGUA

Le Venas Pulmonar in Rheumatic Morbo Cardiac

Super le base de 172 casos in que datos de catheterismo cardiac esseva disponibile, le alterationes pulmono-venose in rheumatic morbo valvulo-cardiac esseva evalutate. Esseva constatate un correlation definite inter le dimensiones del venas del lobo superior e le tension sinistro-atrial. Le venas augmenta lor dimensiones in tanto que le tension se augmenta. Alterationes in le venas del lobo inferior esseva minus constante, sed illos debe esser prendite in consideration insimul con le allargamento del venas del lobo superior como indice del augmentate tension atrial. In disfallimento congestive, le venas de lobo inferior es disproportionatemente allargate.

Nulle notabile alterationes in le apparentia del venas esseva trovate inter le varie lesiones que produce le alterationes de tension, i.e. stenosis mitral, insufficientia mitral, e lesiones aortic.

Laminogrammas delineava le venas de lobo inferior le plus avantagiosemente, sed un plus meticulose inspection revelava ille venas etiam in pelliculas thoracic postero-anterior del typo conventional.

The Cinefluorographic Detection and Recording of Calcifications Within the Heart

Results of 803 Examinations[1]

JOSEPH JORGENS, M.D., Ph.D.,[2] NORMAN BLANK, M.D., and WILLIAM A. WILCOX, M.D.

IN THE PAST, many different methods have been employed for demonstrating calcifications within the heart, including roentgenography (1–4), roentgen kymography (5), and planigraphy (6). Each of these has definite limitations. Over the last two years there have been performed in the Veterans Administration Hospital, Minneapolis, Minn., 803 cinefluorographic examinations for this purpose, and it is the authors' opinion that cinefluorography is now the method of choice for detecting and localizing cardiac calcification.

In the diagnosis, treatment, and prognosis of cardiac disease (7), the detection of calcification within the heart is of significance. Often its recognition in the mitral or aortic valve or in the coronary arteries helps in arriving at a differential diagnosis. Furthermore, it may modify the surgical approach. A calcified mitral valve may be fractured rather than cut. During mitral commissurotomy cerebral embolization occurs more frequently if there is calcification in the valve. In the coronary arteries, calcification means arteriosclerosis. The deposits are usually to be seen in advanced atheroma of the intima and in a patient of forty or fifty may reasonably be taken to indicate a decreased life expectancy.

TECHNIC OF DETECTING CALCIFICATIONS IN THE HEART

Our method of examining the heart cinefluorographically is as follows: In the postero-anterior view the pulsations of the right cardiac border and great vessels are recorded, beginning at the diaphragm and moving upward to include the superior vena cava and azygos vein. In this film sequence, calcifications in the pericardium, right coronary artery, and ascending aorta may be noted (Fig. 1). The second film sequence is a recording of the left heart border from the left subclavian artery down to the left hemidiaphragm. In this view, calcifications in the arch of the aorta, pulmonary artery, left atrium, left coronary artery, and myocardium of the left ventricle are demonstrated. The patient is then turned into a right anterior oblique position and the third sequence is obtained, from the diaphragm to the pulmonary artery and thence down the left heart border to the diaphragm again. These views are excellent for detecting calcifications in the mitral and aortic valves (Fig. 2), and in the right and left

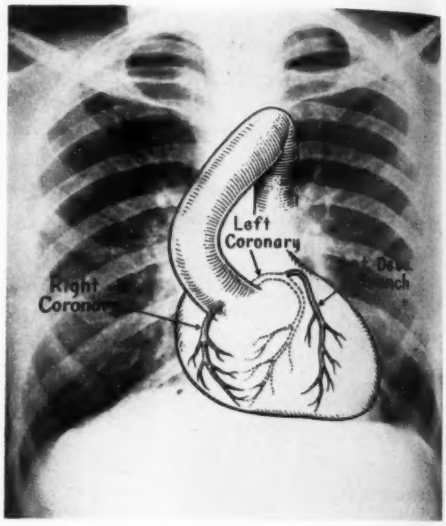

Fig. 1. Diagram of position of coronary arteries in postero-anterior view of chest.

[1] From Veterans Administration Hospital, Minneapolis, Minn. Presented at the Forty-fifth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 15–20, 1959.

[2] Associate Professor, University of Minnesota.

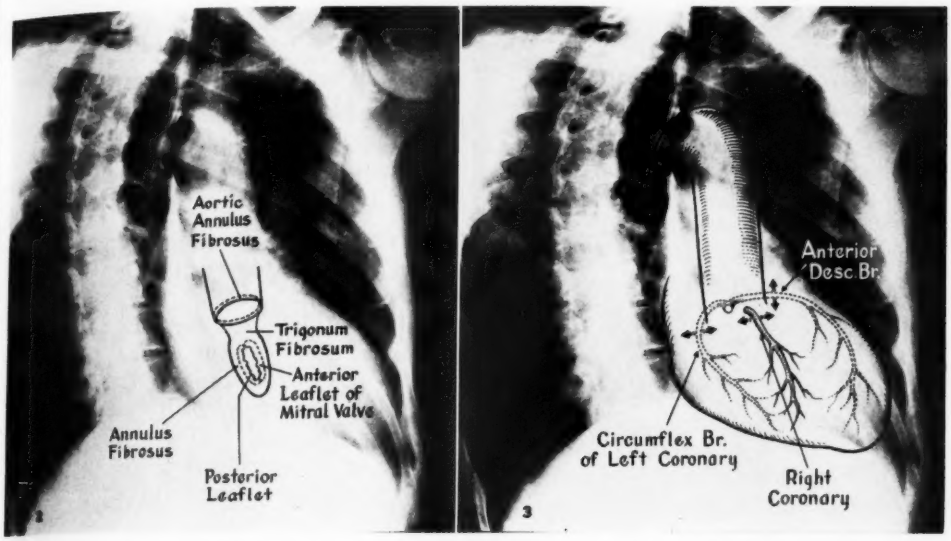

Fig. 2. Right anterior oblique view showing position of the valves of the heart.
Fig. 3. Right anterior oblique view showing position of coronary arteries.

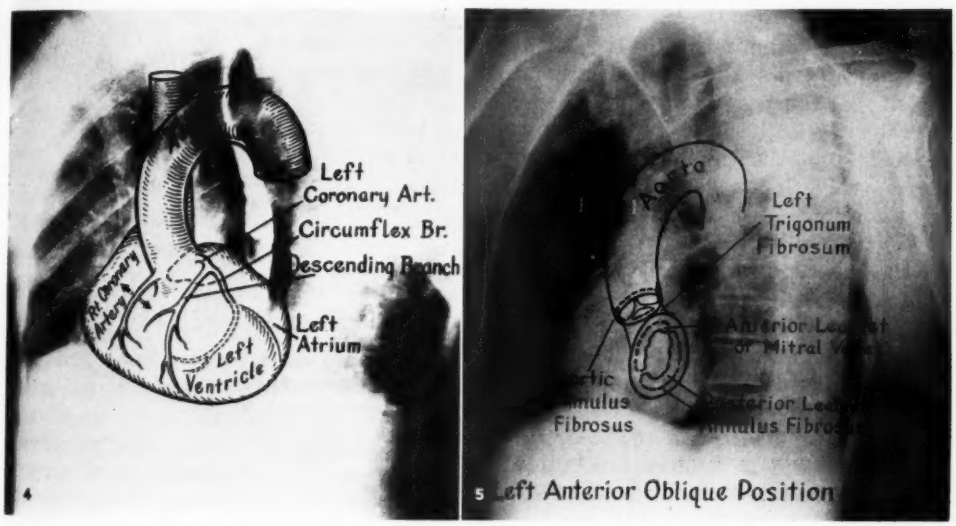

Fig. 4. Left anterior oblique view showing position of the coronary arteries.
Fig. 5. Left anterior oblique view showing position of the valves of the heart.

coronary arteries (Fig. 3). A recording of the right atrium and ascending aorta is next made in the left anterior oblique projection, followed by views of the mid-cardiac mass, which includes the right coronary artery, aortic valve, and left coronary artery (Fig. 4). With the patient still in the left anterior oblique position, a record is made of the pulsation of the posterior border of the heart. This includes the mitral valve area (Fig. 5). Finally, in the right lateral view, beginning in the inferoposterior part of the cardiac silhouette, a sequence is obtained of the

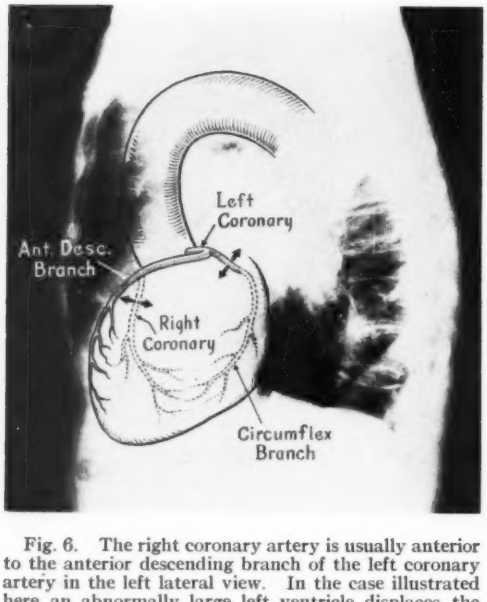

Fig. 6. The right coronary artery is usually anterior to the anterior descending branch of the left coronary artery in the left lateral view. In the case illustrated here an abnormally large left ventricle displaces the left coronary branch anteriorly.

posterior heart border up to the left atrial area and across the aortic and mitral region to the sternum (Fig. 6). This lateral view is the best for observing the movement of the calcified leaflets of the aortic valve. Occasionally, a calcified right coronary artery may be seen moving in the more anterior portion of the heart. In the more posterior portion the mitral valve may be seen.

The entire examination consists of six film sequences, the length of which depends upon the camera's speed of movement through the different areas. Usually 30 to 40 feet of film, at the rate of fifteen frames per second, will be sufficient. At 110 kv the milliamperage will fluctuate between 5 and 15 ma for a person of average size. The total radiation exposure will be about 20 r in air, delivered to a constantly changing skin field through a portal 4.75 inches in diameter.

MATERIAL

Eight hundred and three cinefluorographic examinations of the heart were performed during the last two years at the Minneapolis Veterans Administration Hospital. A majority of the patients were males between forty and seventy years of age, who were referred because of their cardiac symptoms.

ACCURACY OF CINEFLUOROGRAPHY IN DETECTING CALCIFICATIONS WITHIN THE HEART (9)

By means of cinefluorography most of the calcific deposits in the heart are detected, but not all. There are certain limitations inherent both in the method and in the examiner. The latter may make an error in scanning the heart or in identification of a small calcific deposit. Certain physical factors: the size and shape of the calcification and the amount of calcium salt present also enter into the problem of detection. In addition, the thickness and density of the chest wall, the lungs, and the heart will determine, in part, the minimum calcific deposit which can be recorded. A smaller deposit, for instance, can be detected in a thin, emphysematous patient than in one with pulmonary edema and cardiomegaly. Calcifications seen on the cinefluorogram, however, have been checked many times against the findings at autopsy, and the accuracy is impressive.

RESULTS

In our 803 cinefluorographic examinations calcification was discovered as follows:

Left coronary artery	225
Right coronary artery	58
Combined coronary arteries	38
Ascending arch of aorta	21
Pulmonary artery	1
Mitral valve including annular area	89
Aortic valve	103
Aortic annulus only	3
Combination of valves	22
Myocardium	10
Pericardium	10
Location uncertain	11

We consider it remarkable that calcification was detected in the left coronary artery in 225 cases, and in the right coronary artery in 58. In 20 cases the right coronary artery was calcified without associated left coronary artery calcification.

The one pulmonary artery calcification listed was in a patient who had a reversing patent ductus arteriosus; severe pulmonary hypertension was present in this case. The rest of the tabulated findings are self-explanatory and in line with what would be expected in a selected group of patients.

DISCUSSION

Over the last twelve years we have tried all methods in use for detecting calcifications in the heart, including roentgen kymography and planigraphy. The remarkably high number of coronary artery calcifications demonstrated by cinefluorography in the present study is the basis of our contention that this technic is the method of choice. Indeed, we feel that for the first time it is reasonably easy to obtain accurate demonstration of intracardiac calcifications. Very small deposits, measuring perhaps as little as 2 mm., have been detected in hearts that are beating rapidly or are enlarged.

If cinefluorography is unavailable, good roentgenograms or spot-films taken at one-fifteenth of a second or less, at 150 ma, can record obvious cardiac calcifications unless the thorax or heart is extremely large. In the patient with a large heart or thick thorax most heart calcifications can be shown by planigraphy, but small deposits are less likely to be recorded satisfactorily. Roentgen kymography has been used in many institutions through the years, but in most hands has not proved practical or more accurate than ordinary roentgenograms. Cinefluorography is the method of choice, since it is a specific procedure designed to record a moving object.

Usually the position, shape, or movement of the calcification identifies the exact part of the heart which is affected. In any view, however, certain structures may be superimposed, resulting in mistaken identification. If, for instance, calcification is present in the left coronary artery near its ostium, it will be superimposed on the aortic valve in the left anterior oblique view. A differential identification can be made in any of several ways: by recognition of the shape and movement of the aortic valve leaflets, by identification of calcification in the main trunk of the left coronary artery, or, if identification is still impossible, by turning the patient into the right anterior oblique position so that the horizontal portion of the left coronary artery extending from the aorta to the left heart border may be better seen.

There are no real disadvantages in the cinefluorographic examination of the heart. The Westinghouse Cinefluorex has a field 4.75 inches in diameter. While this is not large enough to record the pulsation of the whole heart in one field, this is not a real disadvantage. The major drawback is the cost of the equipment. The image amplifier costs approximately $7,000.00 and the Cinefluorex costs an additional $7,000.00. Some may object, also, to the weight of the unit.

SUMMARY

Over a two-year period, 803 cinefluorographic examinations of the heart were performed at the Veterans Administration Hospital, Minneapolis, Minn. The remarkable number of calcifications demonstrated is attributed to the fact that a selected group was examined and to the use of the cinefluorographic method.

The technic of the examination, which consists of 6 film sequences of the heart and great vessels, is described. The calcifications seen on the cinefluorogram were checked many times against autopsy findings, and the accuracy was impressive.

On the basis of their findings, the authors consider cinefluorography the method of choice for detecting and recording calcifications within the heart.

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SUMMARIO IN INTERLINGUA

Cinefluorographia in le Detection e Registration de Calcificationes Intra le Corde: Resultatos de 803 Examinationes

In le curso de un periodo de duo annos, 803 examines cinefluorographic esseva effectuate al Hospital Minneapolis, Minnesota, del Administration de Veteranos statounitese.

Es describite le technica del examine que consiste de 6 sequentias de pelliculas del corde e del grande vasos. Le calcificationes observate in le cinefluorogrammas esseva comparate multe vices con le constatationes necroptic, e le accuratia esseva frappante. Calcificationes esseva demonstrate in le arterias coronari, le arco ascendente del aorta, le arteria pulmonar, le valvulas mitral e aortic, le anulo aortic, e le myo- e pericardio. Es considerate como specialmente digne de nota que calcificationes esseva detegite in le arteria sinistro-coronari in 225 casos e in le arteria dextero-coronari in 58. In 20 casos, le arteria dextero-coronari esseva calcificate sin associate calcification del arteria sinistro-coronari. Micrissime depositos, de dimensiones de possibilemente non plus que 2 mm, esseva trovate in cordes a pulsation rapide.

Super le base de lor constatationes, le autores considera le cinefluorographia como le methodo de election in le detection e registration de calcificationes intra le corde.

Aortic Configuration in Congenital Heart Disease[1]

EUGENE C. KLATTE, M.D., JOHN A. CAMPBELL, M.D., and PAUL R. LURIE, M.D.

IN THE COURSE of the clinical interpretation of well over 600 angiocardiograms at Indiana University Medical Center during the past twelve years, the aortic configuration was found to be the key to the recognition and differentiation of many primary types of congenital and acquired cardiac lesions. With the use of selective cinecardioangiography during the past three years, the importance of aortic size in differential diagnosis was even more impressive. This knowledge adds specificity to the plain film findings and narrows the field of diagnostic possibility by exclusion of inconsistent aortic findings.

To utilize the aortic configuration to the greatest diagnostic advantage, it is necessary not only to recognize the various morphologic pictures which occur in different lesions, but also to appreciate the frequency and reliability of the roentgenologic evidence as it pertains to the type of altered hemodynamics involved.

It must be remembered that the normal aortic configuration of children and adults is not the same. As a patient ages there are continuous degenerative changes in the aortic wall so that there is a relative increase in aortic size. A normal aortic configuration in a patient fifty years of age would be definitely abnormal in a child of ten. If the normal gradual increase is taken into consideration, the aortic size can be closely related to the volume and pressure of the blood entering the systemic circuit.

In evaluation of the usefulness of the size, shape, and specific aortic contours in the diagnosis of congenital heart disease, a systematic review of the plain films of 610 cases of 12 commonly encountered lesions was carried out, and the results were tabulated. The findings were correlated with the anatomical observations made on angiocardiography, at surgery, or at autopsy. This paper reports our experience in this endeavor.

LEFT-TO-RIGHT SHUNTS

Patent Ductus Arteriosus: The ductus arteriosus is a communication between the inner surface of the aorta and the left pulmonary artery. If this vessel does not close at birth, there is a shunt of blood from the higher-pressure aorta to the lower-pressure pulmonary artery. The amount of flow depends on the relative pressures of the systemic and pulmonary systems and the anatomical size of the ductus, causing enlargement in the caliber of the ascending and transverse aorta. There is an increased blood flow through the aorta proximal to the mouth of the ductus. There may be, also, a localized conical tenting of the aorta at the site of the ductus. This was first described by Rokitansky (1) in 1852 but was of little practical significance until the advent of angiography, when it was rediscovered by Jönsson and Saltzman (2). It is known as the infundibulum of the ductus and can be visualized in 25 to 50 per cent of cases of patent ductus (3, 4) (Fig. 1). It is seen on the posteroanterior radiograph as a convex bulging of the lateral margin of the aorta immediately below the knob.

In the present series the profile of the infundibulum of the ductus was identified in 45 per cent of patients over twenty years of age and in 15 per cent of those under ten. The lower incidence in infants and children may be due in part to the fact that the aortic profile is less easily visualized because of its more medial position, the overlapping thymus, and failure to obtain films in deep

[1] From the Departments of Radiology and Pediatrics, Indiana University Medical Center, Indianapolis, Ind. Presented at the Forty-fifth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 15-20, 1959.

This investigation was supported by the James Whitcomb Riley Memorial Association.

Fig. 1. Patent ductus arteriosus. The ascending aorta is large, and the aortic knob is bulbous. There is an abrupt decrease in aortic size below the ductus arteriosus.

TABLE I: PATENT DUCTUS ARTERIOSUS

Age in Years	Aortic Size			Infundibulum of ductus (per cent)
	Small (per cent)	Normal (per cent)	Large (per cent)	
0–2				
11 cases	0	82	18	9
2–10				
54 cases	0	37	63	17
10–20				
13 cases	0	23	77	23
Over 20				
22 cases	0	0	100	45
TOTAL				
100 cases	0	32	68	23

TABLE II: VENTRICULAR SEPTAL DEFECT

Age in Years	Aortic Size		
	Small (per cent)	Normal (per cent)	Large (per cent)
0–2			
49 cases	77	22	1
2–10			
32 cases	70	27	3
10–20			
9 cases	23	77	0
Over 20			
2 cases	0	100	0
TOTAL			
92 cases	67	30	3

inspiration. The infundibular deformity may also be obscured roentgenologically by the dilated pulmonary artery.

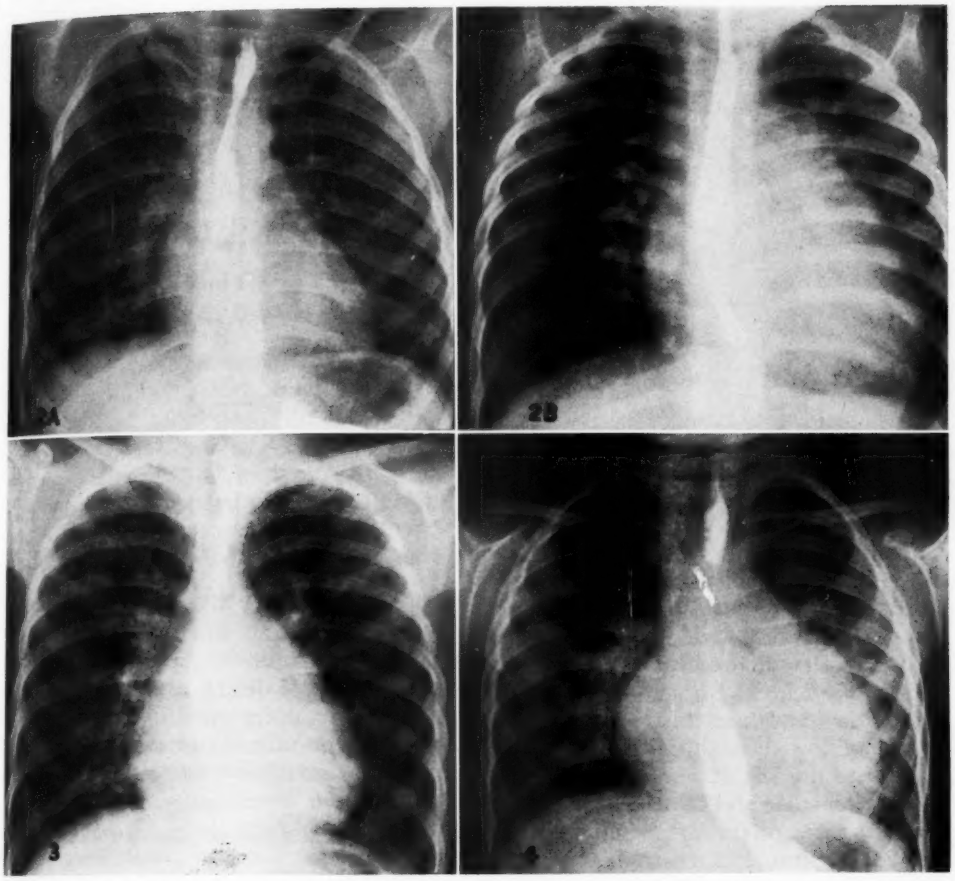
Patent ductus arteriosus may be complicated by pulmonary hypertension. If the increased pulmonary resistance is acquired, secondary to the increased pulmonary blood flow from the ductus, the aorta remains large, whereas if the pulmonary resistance is due to a retention of the fetal type of pulmonary vasculature, the flow through the ductus has always been from right to left and no aortic enlargement is present. Recognition of aortic size is therefore important in differentiating these two conditions since, in the former, ligation of the patent ductus is indicated, while in the latter ligation may result in death from right heart failure.

A study of the plain films of 100 cases of patent ductus arteriosus was made, and the results are listed in Table I. There was an increase in the width and length of the ascending limb and arch of the aorta in 68 per cent.

Ventricular Septal Defect: With a ventricular septal defect the blood is shunted from the left ventricle to the right ventricle, the volume of flow through the shunt depending on the size of the defect and difference in pressure between the two ventricles. With large left-to-right shunts, the volume of blood flow through the aorta is decreased with a consequent decrease in the caliber of that structure. Only when the defect is small or increased vascular resistance balances the flow through the septum is the aorta normal in size (Fig. 2). It was of interest that the aortic size was inversely proportional to the left atrial size. As Singleton (5) points out, left atrial size correlates well with the volume of blood flow through the interventricular defect. Thus aortic size and left atrial size are valuable diagnostic criteria in estimating the volume of interventricular shunts.

Ninety-two cases of ventricular septal defect were reviewed, and the plain film findings are recorded in Table II. The aorta was small in 67 per cent.

Atrial Septal Defects: In ostium secundum defects, the higher pressure in the left atrium causes blood to flow into the right atrium, from which it is recirculated through the right ventricle and lungs. This results in dilatation of the right atrium,



Figs. 2, A and B. Ventricular septal defect. With a small shunt through the interventricular septum, the aorta remains normal in size (A). With a large interventricular shunt, the aorta is small (B). Note the lack of aortic impression on the esophagus.

Fig. 3. Atrial septal defect. The aorta is small.

Fig. 4. Complete anomalous pulmonary venous drainage into the right atrium. The aorta is not well visualized because of enlargement of the pulmonary artery. There is no definite aortic impression on the esophagus.

TABLE III: ATRIAL SEPTAL DEFECT

Age in Years	Aortic Size		
	Small (per cent)	Normal (per cent)	Large (per cent)
0–2			
8 cases	88	12	0
2–10			
38 cases	87	11	2
10–20			
14 cases	85	15	0
Over 20			
8 cases	63	37	0
TOTAL			
68 cases	84	14	2

right ventricle, and pulmonary vasculature to a degree consistent with the size of the defect. The small aortic size reflects the relative decrease in flow through the left ventricle (Fig. 3). In ostium primum defects, the same alteration in hemodynamics exists except that some degree of incompetency of the atrioventricular valves is superimposed.

Sixty-eight cases of atrial septal defects were reviewed and a small aorta was found in 84 per cent. The statistical results are listed in Table III.

Anomalous Pulmonary Venous Return: Anomalous pulmonary drainage may be partial or complete, with drainage into the superior or inferior vena cava, a persistent left vena cava, right atrium, coro-

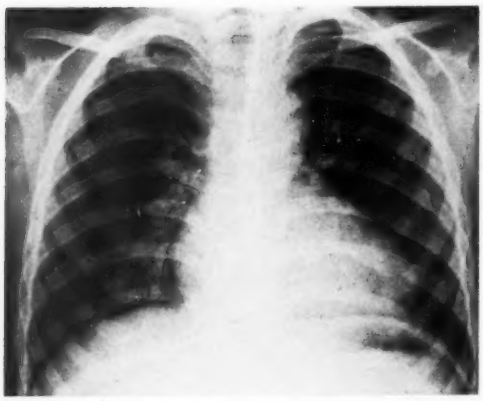


Fig. 5. Tetralogy of Fallot. The entire aortic arch is large, causing a deep impression on the barium-filled esophagus.

nary sinus, azygos vein, or portal system. The end-result is a mixing of a variable amount of pulmonary and systemic blood in the right atrium, with the passage of desaturated blood into all heart chambers, and patients are therefore cyanotic. From the right atrium the blood may flow into the right ventricle, through the pulmonary vasculature and back to the right atrium, or it may flow through the patent foramen ovale into the left atrium and thence into the left ventricle and out the aorta. Since the flow through the left heart is reduced, the left atrium, left ventricle, and aorta are quite small. The right atrium is usually enlarged (Fig. 4).

A persistent left superior vena cava is frequently present and may receive the entire pulmonary venous drainage, producing the so-called "figure of 8" type of cardiac contour.

In our series of 19 cases (Table IV), the aorta was seen to be small in 32 per cent, but in 63 per cent the aortic contour was obscured by the overlying superior vena cava or persistent left vena cava.

TABLE IV: ANOMALOUS PULMONARY VENOUS RETURN

Age in Years	Aortic Size			Aorta not Visualized (per cent)
	Small (per cent)	Normal (per cent)	Large (per cent)	
0–2				
11 cases	27	0	0	73
2–10				
7 cases	43	0	0	57
10–20				
None	0	0	0	0
Over 20				
1 case	0	100	0	0
TOTAL				
19 cases	32	5	0	63

Summary on Left-to-Right Shunts: The aortic configuration in patent ductus arteriosus offers a key to its differentiation from the other anomalies producing left-to-right systemic pulmonary shunts, namely, atrial septal defects, ventricular septal defects, and anomalous pulmonary venous return.

Analysis of these cases shows that only in patent ductus is the aorta usually large, widened, and elongated, the other left-to-right shunts having small aortas, as a rule. Aortic size is particularly helpful in differentiating patent ductus from ventricular septal defect where, except for a small aorta, the configuration is identical.

TETRALOGY OF FALLOT

The tetralogy of Fallot consists of pulmonary infundibular stenosis, a ventricular septal defect, and a predominant right-to-left interventricular shunt. The presence or absence of dextroposition of the aorta is difficult to determine even at postmortem examination, since the membranous portion of the ventricular septum normally is obliquely directed to the right. Because of the pulmonary stenosis, blood from both ventricles enters the aorta. If the stenosis is severe, much of the blood supply to the lungs may be derived from large bronchial arteries or a patent ductus arteriosus. The aorta becomes large secondary to this increased volume of blood flow (Fig. 5).

TABLE V: TETRALOGY OF FALLOT

Age in Years	Aortic Size			Right-sided Aorta (per cent)
	Small (per cent)	Normal (per cent)	Large (per cent)	
0–2				
19 cases	0	37	63	32
2–10				
41 cases	0	42	58	24
10–20				
12 cases	8	25	67	25
Over 20				
7 cases	0	14	86	43
TOTAL				
79 cases	1	36	63	28

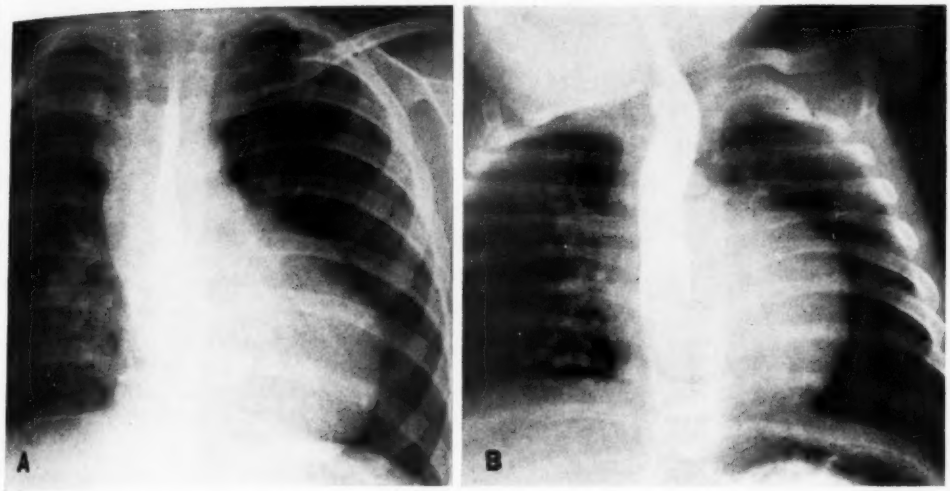


Fig. 6, A and B. Tricuspid atresia. Fig. 6A shows a case of tricuspid atresia without transposition; 6B is a case with transposition. Note that in 6A the aorta is large, while in 6B it is small. Aortic size is an important point in differentiating these two conditions.

Seventy-nine cases of tetralogy of Fallot were studied, and the results are tabulated in Table V. The aorta was large in 63 per cent of those studied. This could be determined by direct observation on the postero-anterior projection and by the large aortic impression on the barium-filled esophagus on the lateral and oblique projections. There was not a definite difference in the percentage of aortic enlargements in infants under two years of age and older patients. A right aortic arch was found in 28 per cent of cases.

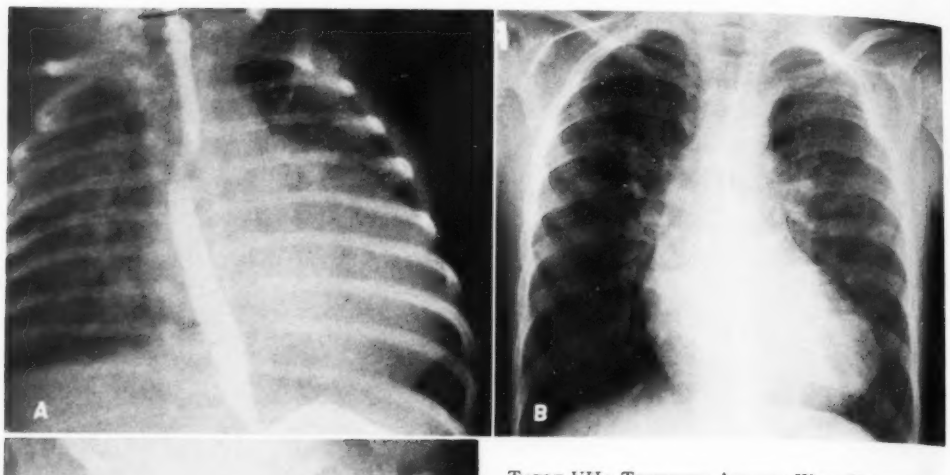
TRICUSPID ATRESIA

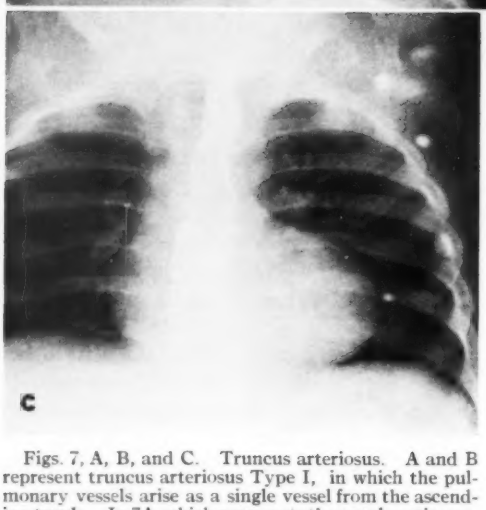
Secondary to atresia of the tricuspid valve, blood from the right atrium is shunted through a patent foramen ovale into the left atrium and then passes through the mitral valve into the left ventricle. If a ventricular septal defect is present, a small amount of blood is shunted into a small right ventricular cavity and then into the pulmonary artery. If the ventricular septum is intact, all the blood from the left ventricle enters the aorta. In both conditions the blood supply to the lungs is primarily from dilated bronchial arteries or a patent ductus arteriosus. The aorta enlarges as a result of the increased volume of blood flowing through it. Among 14 cases of tricuspid atresia without transposition, the aorta was definitely enlarged in 86 per cent (Table VI).

TABLE VI: TRICUSPID ATRESIA WITHOUT TRANSPOSITION

Age in Years	Aortic Size			Right-Sided Aorta (per cent)
	Small (per cent)	Normal (per cent)	Large (per cent)	
0–2 10 cases	10	10	80	50
2–10 3 cases	0	0	100	33
10–20 1 case	0	0	100	0
TOTAL 14 cases	7	7	86	43

Tricuspid atresia is frequently associated with transposition of the great vessels. In our series this was true in 4 of 18 cases (22 per cent). In this group, blood from the left ventricle flows into the pulmonary artery, and a smaller amount flows through a ventricular septal defect into a small right ventricle and then into the aorta. There is thus a decrease in the volume of blood going into the aorta, and the aorta is small. This was true of 3 of our 4 cases (Table VII). The only case of





Figs. 7, A, B, and C. Truncus arteriosus. A and B represent truncus arteriosus Type I, in which the pulmonary vessels arise as a single vessel from the ascending trunk. In 7A, which represents the usual aortic configuration, the entire aortic arch is not visualized. Fig. 7B is a less common appearance, in which the ascending trunk is large and the transverse and descending aorta is normal to small. Fig. 7C is a Type IV truncus, in which pulmonary vessels arise from the descending aorta. These cases are inseparable clinically or radiographically from tetralogy of Fallot.

tricuspid atresia with transposition associated with a normal aorta was one in which pulmonary stenosis was also present. In that instance a greater percentage of blood was shunted through the ventricular septal defect into the right ventricle and out the aorta.

In summary, the aorta is large in tricuspid atresia without transposition, while the aorta is small in tricuspid atresia with transposition (Fig. 6). Aortic size, therefore, has been the best diagnostic point in differentiating these two conditions. A right aortic arch was present in 8 of 18 cases (44 per cent).

TABLE VII: TRICUSPID ATRESIA WITH TRANSPOSITION

Age in Years	Aortic Size: Small (per cent)	Normal (per cent)	Large (per cent)	Right-Sided Aorta (per cent)
0–2				
1 case	100	0	0	0
2–10				
3 cases	67	33	0	67
TOTAL				
4 cases	75	25	0	50

TRUNCUS ARTERIOSUS

Truncus arteriosus is a condition in which only a single arterial vessel leaves the heart; there must be no remnant of a second vessel. The pulmonary arteries usually arise from the ascending portion of the trunk. In a review of the literature, Collett and Edwards (6) found this to be true in 70 of 80 cases. These authors further subdivided cases in which the pulmonary arteries arose from the ascending aorta into those arising as a single vessel which subsequently divided and those in which the pulmonary vessels arose from the posterior or lateral surface of the ascending trunk. A fourth type of truncus arteriosus is one in which the sixth aortic arch fails to develop, so that the pulmonary blood supply is only from dilated bronchial arteries.

TABLE VIII: TRUNCUS ARTERIOSUS TYPES I, II, AND III*

Age in Years	Aortic Size: Ascending Small (per cent)	Ascending Normal (per cent)	Ascending Large (per cent)	Transverse and Descending Small (per cent)	Transverse and Descending Normal (per cent)	Transverse and Descending Large (per cent)	Right-Sided Aorta (per cent)
0–2 8 cases	87	0	13	100	0	0	13
2–10 2 cases	50	0	50	100	0	0	0
TOTAL 10 cases	80	0	20	100	0	0	10

* The classification of truncus arteriosus used is that of Collett and Edwards (6).

TABLE IX: TRUNCUS ARTERIOSUS, TYPE IV

Age in Years	Aortic Size: Small (per cent)	Aortic Size: Normal (per cent)	Aortic Size: Large (per cent)	Right-Sided Aorta (per cent)
0–2 2 cases	0	0	100	0

Our material consists of 12 cases (Tables VIII and IX). In 10 cases in which the pulmonary arteries arose from the ascending trunk, the transverse and descending aorta was small. In 2 of these cases, the ascending trunk was large. In the other 8 cases, the entire aortic arch was small and usually not visualized (Fig. 7). This configuration occurs because the greatest volume of blood entering the ascending trunk goes immediately into the pulmonary arteries, since the pulmonary vascular resistance is less than the systemic.

In 2 cases with Type IV truncus arteriosus the aorta was large, since the entire cardiac output coursed through that vessel to the level of the bronchial arteries.

In summary, in true truncus arteriosus the aorta is usually small, since the major part of the blood in the ascending trunk immediately enters the pulmonary arteries. Type IV truncus arteriosus, in which the pulmonary vasculature arises from the descending aorta, cannot be differentiated from the tetralogy of Fallot. Since the latter condition is much more common, the radiological diagnosis of truncus arteriosus should not be made in cases with a large aortic arch.

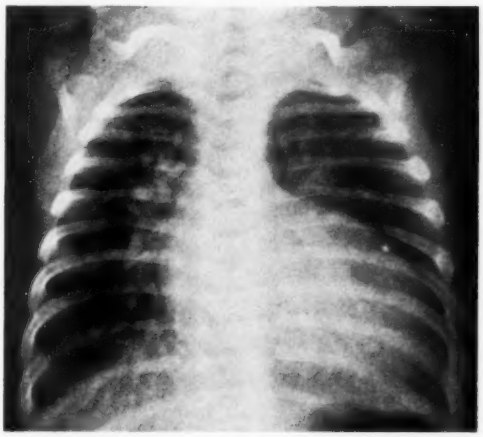


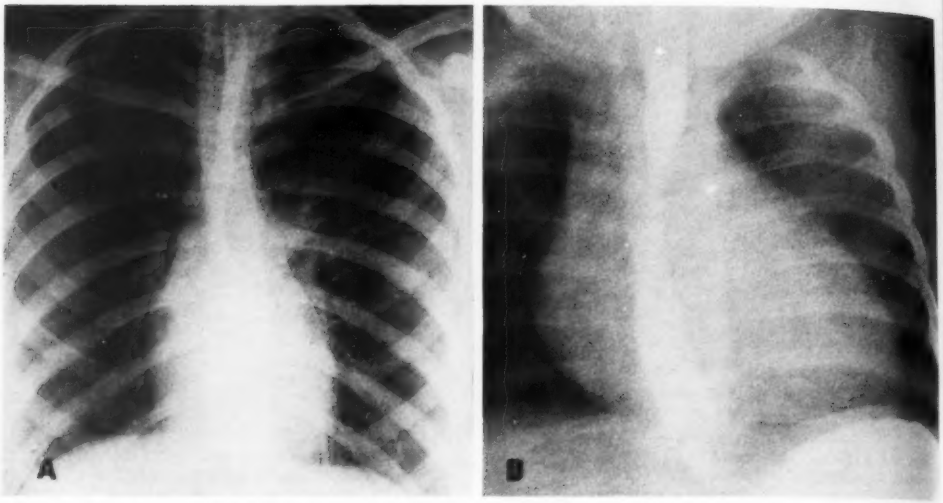
Fig. 8. Transposition of the great vessels. Due to the medial position of the aorta, it is not visualized on the postero-anterior view. The pulmonary artery is directly posterior to the aorta, so that the base of the heart is narrow.

TABLE X: TRANSPOSITION OF GREAT VESSELS

Age in Years	Aortic Size: Small (per cent)	Aortic Size: Normal (per cent)	Aortic Size: Large (per cent)
0–2 32 cases	94	6	0
2–10 2 cases	100	0	0
TOTAL 34 cases	94	6	0

TRANSPOSITION OF GREAT VESSELS

In transposition of the great vessels, the aorta arises from the anterior or right ventricle and the pulmonary artery arises from the posterior or left ventricle. The base of the heart usually appears quite narrow in the postero-anterior view, due to a relative change in the position of the aorta and pulmonary artery (7–10) (Fig. 8). The aorta lies anteriorly and courses posteriorly in a wide curve in the sagittal plane. At times the aortic root lies far to the left and the aortic arch is medial (9). The pulmonary artery is directly posterior to the aorta. Thirty-four cases of transposition were studied. The aortic profile was small in 32 and was not visualized in 9 (Table X). It was of interest that there were only 2 cases in which an aortic impression on the esophagus was seen. Angiographically, the aortas in these cases are normal in caliber, the



Figs. 9, A and B. Pulmonary stenosis. Fig. 9A is a roentgenogram of a fourteen-year-old girl with moderate pulmonary valvular stenosis. Note the small aorta. Figure 9B is a roentgenogram of a cyanotic two-year-old girl with severe pulmonary valvular stenosis and a right-to-left interatrial shunt. The radiographic appearance is similar to tetralogy of Fallot with the exception that the aorta is small. (Compare with Fig. 5.)

apparent decrease in aortic size on plain films being due to the abnormal position of this structure in the base of the heart.

PULMONARY STENOSIS

If pulmonary stenosis is moderate to severe, a decreased volume of blood will pass from the right ventricle into the pulmonary artery and a decreased volume of blood will flow through the left atrium, left ventricle, and aorta. The results of aortic analysis of 74 patients with pulmonary valvular stenosis are recorded in Table XI. It will be noted that the aorta was small in 53 per cent of these cases.

Twenty patients were grossly cyanotic at rest. In these cases there were tight pulmonary valvular stenosis and a markedly elevated right ventricular diastolic pressure and right atrial pressure, with a large right-to-left interatrial shunt. Poststenotic dilatation of the pulmonary artery was absent in 15 of these patients, so that it would be difficult to differentiate this group from tetralogy of Fallot. The aortic size was an extremely important differential point (Fig. 9). The aorta was large in only 3 of the group (15 per cent) and was small in 16 (80 per cent). As was previously stated, the aorta was large in 63 per cent of patients with tetralogy of Fallot and was rarely small.

TABLE XI: PULMONARY STENOSIS

Age in Years	Aortic Size		
	Small (per cent)	Normal (per cent)	Large (per cent)
0–2			
7 cases	72	14	14
2–10			
49 cases	53	41	6
10–20			
14 cases	36	64	0
Over 20			
4 cases	75	25	0
TOTAL			
74 cases	53	42	5

AORTIC STENOSIS

With aortic stenosis there is dilatation of the aorta above the valve. The dilatation of the ascending aorta is thought to be secondary to the increased turbulence of the blood flow and the increased lateral pressure secondary to the deceleration of blood after it passes through the aortic valve. Thirteen cases of congenital aortic stenosis were studied, and definite dilatation of the ascending aorta was apparent on the plain film in 8 (Table XII) (Fig. 10).

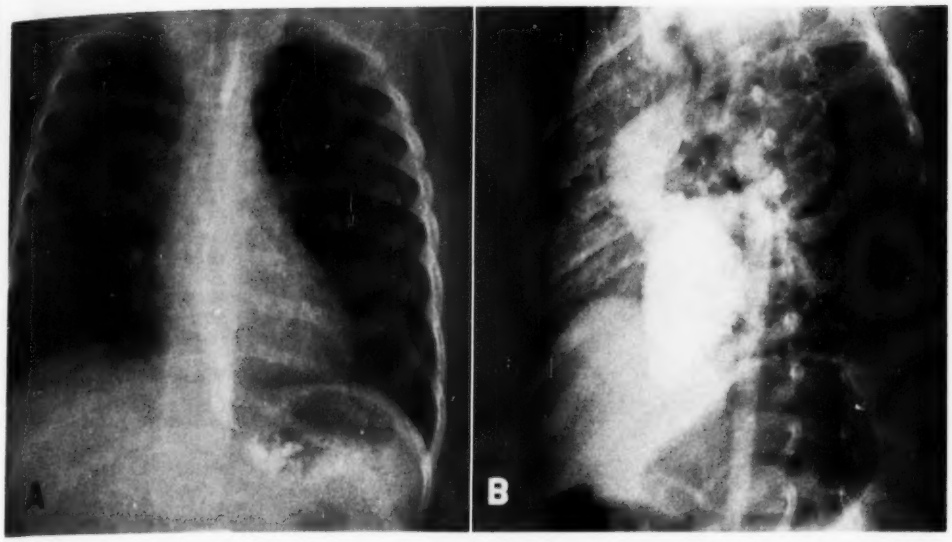


Fig. 10, A and B. Aortic stenosis. Note the post-stenotic dilatation of the ascending aorta which extends into the innominate artery.

TABLE XII: AORTIC STENOSIS

Age in Years	Aortic Size: Ascending Small (per cent)	Ascending Normal (per cent)	Ascending Large (per cent)	Transverse Small (per cent)	Transverse Normal (per cent)	Transverse Large (per cent)
0-2						
1 case	0	0	100	0	100	0
2-10						
5 cases	0	60	40	0	60	40
10-20						
5 cases	0	40	60	0	60	40
Over 20						
2 cases	0	50	50	0	50	50
TOTAL						
13 cases	0	38	62	0	62	38

The dilatation extended into the transverse aorta in 3 of these cases. The fluoroscopic findings in aortic stenosis are typical. There is a marked systolic thrust of the ascending aorta which does not extend into the transverse or descending aorta unless there is associated aortic insufficiency.

Two cases of subaortic stenosis were studied. One case showed dilatation of the ascending aorta. In the other case the aorta appeared normal.

FIBROELASTOSIS

Fibroelastosis is characterized by subendocardial fibroelastic proliferation, usually limited to the wall of the left ventricle and left atrium, marked ischemic changes of the myocardium, very poor ventricular contraction, and a markedly decreased cardiac output. Because the volume of blood passing through the aorta is decreased, there is a small aorta (Fig. 11). Ten cases of fibroelastosis were studied: 8 in children under two, 1 in the two-to-ten-year group, and 1 in a patient over twenty. In every instance the aorta was small.

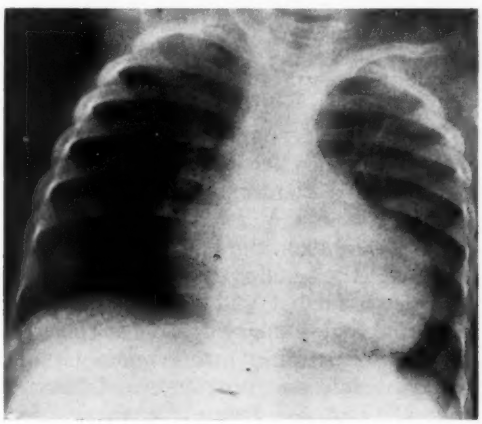


Fig. 11. Fibroelastosis. The aorta is small.

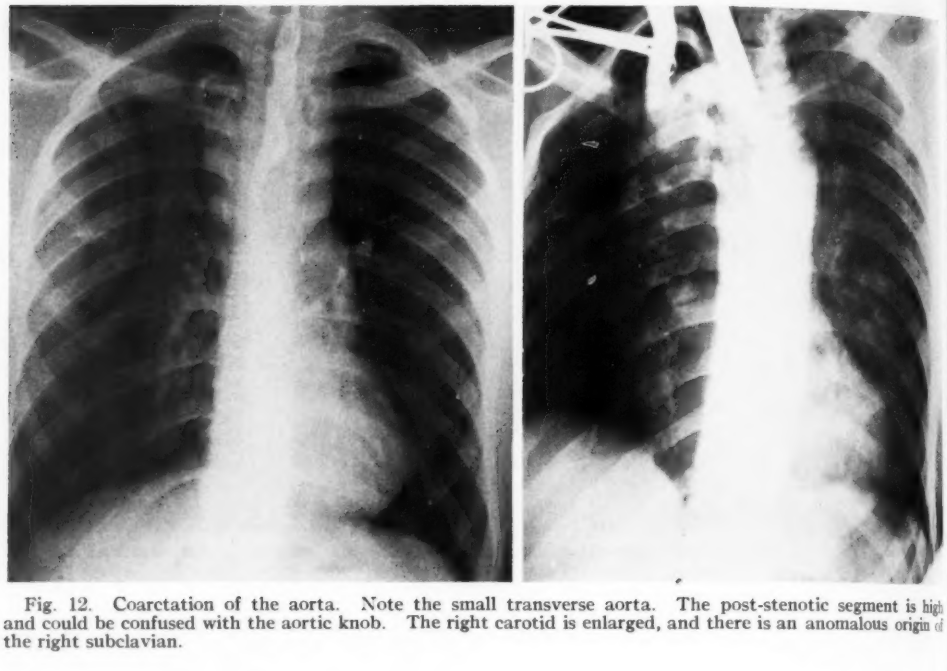


Fig. 12. Coarctation of the aorta. Note the small transverse aorta. The post-stenotic segment is high and could be confused with the aortic knob. The right carotid is enlarged, and there is an anomalous origin of the right subclavian.

COARCTATION OF THE AORTA

The aortic configuration in coarctation of the aorta has been described by a number of investigators (11–16). In this condition there is a constriction of the aorta at or below the ligamentum arteriosum. At the level of the coarctation there is often a medial and anterior buckling, presumably secondary to traction exerted by the ligamentum arteriosum. Usually the ascending aorta is large and there is narrowing of the transverse aortic arch. The normal aortic knob is formed by the junction of the transverse and descending aorta. In coarctation the aorta is narrow at this level, and a normal knob is rarely observed. The left subclavian artery is frequently enlarged. That vessel, due to the medial and forward buckling of the aorta at the coarctation site, may originate at a lower and more medial position than normal, becoming border-forming on the postero-anterior projection, mimicking the appearance of the aortic knob. The innominate artery is frequently enlarged and, together with the large subclavian, widens the superior mediastinum. One of our patients was scheduled for surgical exploration of a superior mediastinal mass before the diagnosis was recognized roentgenologically.

TABLE XIII: COARCTATION OF AORTA

Age in Years	Ascending Aorta Large (per cent)	Post-Stenotic Segment (per cent)	Left Subclavian Large (per cent)	Innominate Large (per cent)
0–2 25 cases	24	32	12	12
2–10 21 cases	67	71	67	38
10–20 24 cases	63	75	79	8
Over 20 21 cases	57	62	76	57
TOTAL 91 cases	51	59	57	34

In the postero-anterior view the left lateral profile of the upper mediastinum may form a discontinuous line, while the upper border in most cases is the dilated left subclavian artery and the lower border is the aorta distal to the coarctation. The post-stenotic portion of the aorta is generally dilated. This dilatation, together with the forward buckling of the aorta at the

Figs. 13 and 14. Coarctation of the aorta. In Fig. 13 the left subclavian artery is large, forming a "pseudo-knob." The post-stenotic segment is visualized both along the left mediastinal border and as it displaces the esophagus to the right. In Fig. 14 the ascending aorta is large and the transverse aorta is small. The post-stenotic segment is visualized both medially and laterally.

TABLE XIV: INCIDENCE OF AORTIC SIZE IN 519 CASES OF CONGENITAL HEART DISEASE

Type of Lesion	Number of Cases	Aortic Size		
		Small (per cent)	Normal (per cent)	Large (per cent)
Patent ductus arteriosus	100	0	32	68
Ventricular septal defect	92	67	30	3
Atrial septal defect	68	84	14	2
Anomalous pulmonary venous return*	19	32	5	0
Tetralogy of Fallot	79	1	36	63
Tricuspid atresia without transposition	14	7	7	86
Tricuspid atresia with transposition	4	75	25	0
Truncus arteriosus, Types I, II, III	10	80	0	20
Truncus arteriosus, Type IV	2	0	0	100
Transposition of great vessels	34	94	6	0
Pulmonary stenosis	74	53	42	5
Aortic stenosis	13	0	38	62
Fibroelastosis	10	100	0	0

* Aorta not visualized in 63 per cent of cases

coarctation site, often causes a lateral and posterior concave impression on the barium-filled esophagus. If the coarctation is high, the post-stenotic segment may mimic a normal aortic knob, both in its profile and in its impression on the esophagus (Figs. 12–14).

Of interest is the fact that in only 4 of 91 cases reviewed was forward displacement of the esophagus demonstrated on the lateral and left anterior oblique views without an associated post-stenotic dilatation on the postero-anterior film. The incidence of the other roentgen findings is given in Table XIII.

SUMMARY

1. The aorta is enlarged in patent ductus arteriosus, tetralogy of Fallot, tricuspid atresia without transposition, truncus arteriosus Type IV, aortic stenosis, and coarctation.

2. The aorta is decreased in size in atrial septal defects, ventricular septal defects, anomalous pulmonary venous return, truncus arteriosus Types I, II, and III, pulmonary stenosis, tricuspid atresia with transposition, transposition of the great vessels, and fibroelastosis.

3. In coarctation, patent ductus arteriosus, and aortic stenosis, the aortic configuration may be sufficiently characteristic to permit roentgen identification.

4. The aortic size and profile are the key to differentiating patent ductus arteriosus from other left-to-right shunts, particularly ventricular septal defects where the roentgen appearance is otherwise identical.

5. The large aorta of tetralogy of Fallot serves to distinguish this condition from

pulmonary stenosis with right-to-left interatrial shunt, where the aorta is usually small.

6. The large aorta is a useful sign in differentiating triscuspid atresia from tricuspid atresia with associated transposition of the great vessels, where the aorta is small.

7. Specific aortic contour is as reliable a diagnostic sign of coarctation of the aorta as was rib notching. This is of practical value because one sign may be present when the other is absent.

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SUMMARIO IN INTERLINGUA

Configuration Aortic in Congenite Morbo Cardiac

Esseva effectuate un studio systematic del configuration aortic in le pelliculas conventional de 610 casos de dece-duo communmente incontrate congenite anormalitates cardiac, omnes verificate chirurgicamente, per angiocardiographia, o al necropsia.

Le aorta es allargate in patente ducto arteriose, tetralogia de Fallot, atresia tricuspidic sin transposition, trunco arteriose typo IV (in que le sexte arco aortic remane non-disveloppate), stenosis aortic, e coarctation. Le dimensiones del aorta es reducite in defectos atrio-septal e ventriculo-septal, anormal retorno pulmono-venose, trunco arteriose typos I, II, e III, stenosis pulmonar, atresia tricuspidic con transposition, transposition del grande vasos, e fibroelastosis.

Le grande aorta incontrate in tetralogia de Fallot servi a differentiar iste condition ab stenosis pulmonar con derivation interatrial ab le dextera ad le sinistra in que le aorta es usualmente micre. Le grande aorta es etiam un signo utile in distinguer atresia tricuspidic sin transposition del grande vasos ab atresia tricuspidic con ille transposition. In le secunde de iste conditiones le aorta es micre.

In coarctation, patente ducto arteriose, e stenosis aortic, le configuration del aorta pote esser sufficientemente characteristic pro render possibile le identification de ille conditiones per roentgenographia. Le dimensiones e le profilo del aorta es le clave al differentiation inter patente ducto arteriose e altere formas de derivation sinistro-dextere, specialmente defectos ventriculo-septal, in que le configuration roentgenographic es alteremente identic.

Papillary Opacification in Excretory Urography

The So-Called Pyelotubular Reflux[1]

FELIX G. FLEISCHNER, M.D., SVEN BELLMAN, M.D.,[2] and E. M. HENKEN, M.D.

RADIOLOGISTS and urologists are familiar with various types of pyelorenal reflux occasionally observed during retrograde pyelography. After the introduction of ureteral catheterization by Casper in 1895 and of pyelography by Volker and Lichtenberg in 1906, a considerable time elapsed before gross injuries, either by the catheter or by the injected contrast medium, were first recognized and correctly interpreted. Hinman and Lee-Brown, in 1924, investigated these injuries and coined the term pyelovenous backflow or reflux. Only pyelotubular reflux is true backflow. The other types are the result of traumatic rupture, mostly at the calyceal fornix, and have been described as pyelolymphatic, pyelovenous, pyeloparenchymal, subcapsular, and peripelvic reflux or extravasation. These injuries are attributed to the catheter proper or to the increase in intrapelvic pressure during injection of the medium.

Olsson in 1948 described similar types of reflux occurring during excretory urography. Since they have been observed in the presence of an obstructing ureteral stone and during or immediately after a colic, and with external ureteral compression, they, too, have been attributed to increased intrapelvic pressure.

Olsson specifically excluded from his discussion pyelotubular reflux, but without explaining its nature. This type of "reflux" has been observed during excretory urography with increasing frequency during the past few years. The "staining of the papillae" is often referred to as "sunburst" or "brush-like" opacification (Fig. 1). A faint or moderately dense homogeneous shadow occupies the area of the papilla, fading out toward the base of the pyramid. This shadow is lighter than that of the concentrated contrast medium in the corresponding calyceal cup. Usually all papillae of a kidney are thus stained in about equal density; occasionally the "brushes" are more conspicuous in some pyramids than in others. A difference in degree is also seen on comparison of the right and left kidneys in certain urographic studies.

Fig. 1. Impregnation of the papillae, "brushes," in an excretory urogram in a healthy young subject. (Hypaque, 50 per cent, 20 ml.; five minutes after intravenous injection; right kidney.)

It has been fairly general practice to perform excretory urography with appli-

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cation of external compression in order to delay the urinary flow, promote stasis in the ureters and renal pelves, and thus increase the concentration of the contrast medium. It was postulated that stasis in the renal pelvis, with resultant increased intrapelvic pressure, might cause urinary outside into the papillae and tubules of the pyramids in retrograde pyelography. Since, however, the renal pelvis is known not to have a concentrating capacity, it is not at all clear why a solution forced back from the renal pelvis into the papillary ducts and collecting tubules could opacify

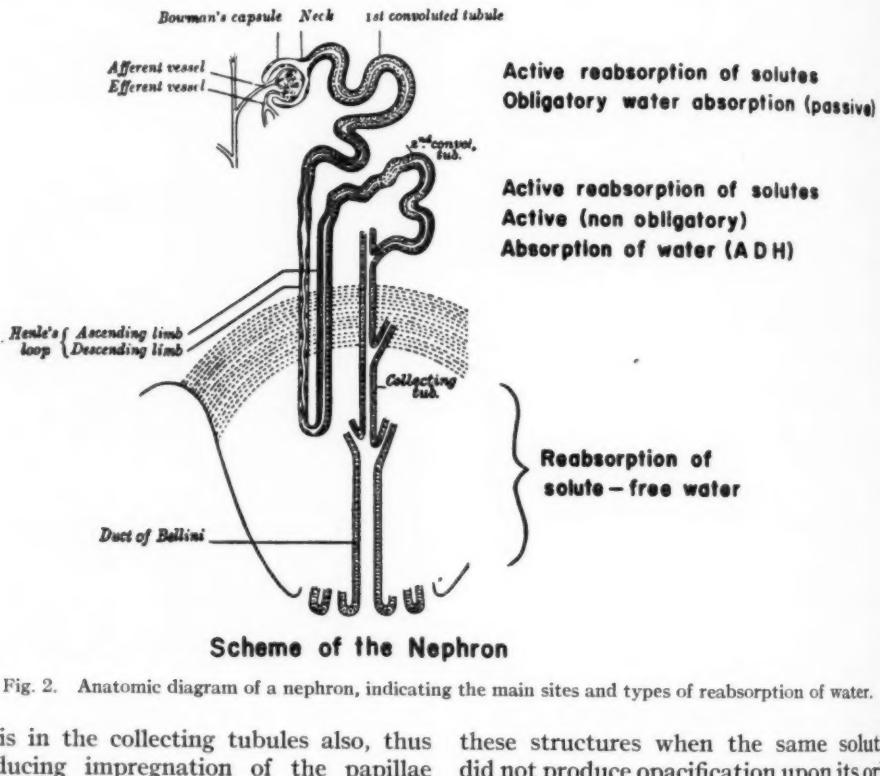

Fig. 2. Anatomic diagram of a nephron, indicating the main sites and types of reabsorption of water.

stasis in the collecting tubules also, thus producing impregnation of the papillae (Olsson, Bauer, Sengpiel, Hinkel). Such an explanation, however, leaves several questions unanswered. It is difficult to understand, for example, how urine, which is nonopaque when passing through the collecting tubules and papillary ducts, should become opaque simply by being held up there as a result of stasis alone. Similarly the hypothesis that dilatation of the tubules and ducts provides the basis for the opacification (Hinkel) is hardly acceptable on quantitative-morphologic grounds.

Pyelotubular reflux clearly connotes the forcing of contrast medium from the these structures when the same solution did not produce opacification upon its original passage through them in excretory urography.

The superior opacification obtained with the newer tri-iodinated urographic contrast media has caused us occasionally to omit external ureteral compression. Nevertheless, opacification of the renal pyramids is more frequently seen than ever. An explanation for this phenomenon may be provided by a consideration of renal physiology.

NORMAL WATER METABOLISM

Some anatomic facts will be briefly reviewed as an introduction to our present

concepts of renal water metabolism. The Malpighian corpuscle or glomerulus, a tuft of capillaries, is imbedded in Bowman's capsule, which drains into the proximal convoluted tubules and thence into the loop of Henle, the distal convoluted tubule, the collecting tubules, and the papillary ducts (ducts of Bellini).

The production of urine starts with filtration from the glomerular capillaries into Bowman's capsule. This glomerular filtrate is isosmotic with protein-free plasma as far as filtrable unbound solutes are concerned (Fig. 2). During passage through the proximal tubule and Henle's loop, a considerable amount of solute is reabsorbed and some is secreted. This tubular reabsorption of solute is accompanied by compulsory water absorption. As a result, a diminished volume of urine, of altered composition although still isosmotic, enters the distal convoluted tubule; the total glomerular filtrate for a twenty-four-hour period is 180 liters and this is reduced to 1.5 liters of bladder urine. Eighty-five per cent of this reduction in volume has occurred in the proximal tubule, due to active reabsorption of solute and the associated passive diffusion of water. The other 15 per cent, corresponding to 27 liters, is reabsorbed in two separate compartments. In the distal convoluted tubules solute and water are actively reabsorbed. Solute reabsorption in this area is not accompanied by obligatory water absorption. Water reabsorption in the distal tubule is controlled by the antidiuretic hormone of the pituitary gland. When this hormone is present in physiological amount, water is absorbed in proportion to the osmotic gradient in the distal tubule, so that a smaller volume of isosmotic fluid is delivered to the more distal concentrating area.

The final concentrating operation consists of a continuing reabsorption which removes a considerable quantity of "solute-free" water from isosmotic tubular urine. The reabsorption averages about 5 c.c./min. per 100 c.c. of tubular urine. Investigations of the last few years by Wasson and Anslow, Homer W. Smith, and Berliner, and the micropuncture studies of Wirz and Gottschalk, have led to the conclusion that this concentrating operation occurs in the collecting system, *i.e.*, collecting tubules and papillary ducts. While most of these investigations concerned the tubules and the tubular epithelium, other studies, especially those of Wirz, Hargitay, and Kuhn, considered the osmolarity of the kidney tissue as a whole. The loop of Henle, which is surrounded by the vasa recta and dips deep into the medulla and the pyramids, is considered to act as a hair-pin countercurrent system which creates in the pyramids an environment of the highest osmolarity. By microcryoscopic studies of the rat kidney, regions of equal osmotic pressure were found to lie in concentric shells, with the tip of the papilla as the central point of highest osmotic pressure (Fig. 3). Furthermore, recent observations by Lassen, Longley, and Lilienfield (1958), made with I^{131}-labeled serum albumin, revealed a high albumin concentration in the mammalian papilla. These conditions in the papillary tissue provide a gradient for absorption of solute-free water from the collecting tubules and favor the rapid transport of water from the interstitial spaces into the papillary blood vessels. The importance of these processes for the concentrating operation of the urine is obvious.

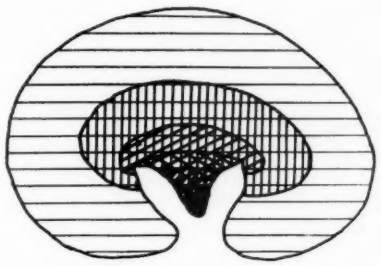

Fig. 3. Diagrammatic section of rat kidney, indicating regions of equal osmotic pressure arranged in concentric shells, with the papilla as central point of highest osmotic pressure. From Wirz, Hargitay, and Kuhn.

EXPERIMENTAL STUDIES

These physiologic considerations provide a rationale for the investigations to be described. In order to explain the saturation of the papillae with contrast material, it was postulated that the kidney handles these media as it does other solutes. The following experiments were performed to test this assumption.

Material and Methods: Ten albino rabbits weighing between 2 and 3 kg. were anesthetized with intravenous pentobarbital sodium (Nembutal) (30 mg./kg. body weight). Hypaque, 35 per cent (Winthrop Laboratories), in a dose of 2.5 c.c. per kg. body weight, was injected with the Nembutal. Five to ten minutes later, the abdomen was opened and the left kidney was removed. Slices, approximately 2 mm. thick, were cut by hand transversely through the middle part of the kidney and immediately microradiographed.

The microradiographs were obtained with a Machlett OEG 50 A microradiography tube, at 15 to 18 kvp, 16 ma, a focus-to-film distance of 25 cm., and exposure times of five to fifteen seconds. They were taken on Gevaert Duplo Ortho Microfilm, wrapped in black paper, the fresh kidney slices being placed directly on the paper wrapping. Development was for three minutes at room temperature in Kodak D 19 developer. These contact microradiographs at unit magnification were enlarged photographically.

Results: All kidney slices showed the same basic pattern (Fig. 4). The soft-tissue shadow varied with the thickness of the hand-cut slices, but this variation could easily be recognized. In the cortical zone several radiating streaks of radiopaque material stood out quite clearly, apparently representing Henle's loops and collecting tubules. Glomeruli were not demonstrable. In sharp contrast to the cortex, the medulla was characterized by a zone of concentrated opaque matter made up of numerous images of tubules. In many sections the part of the pyramid next to the cortico-medullary border showed less dense opacification; in others there was little difference from the border zone. In all specimens the density of radiopaque material was greatest in the papilla of the pyramid.

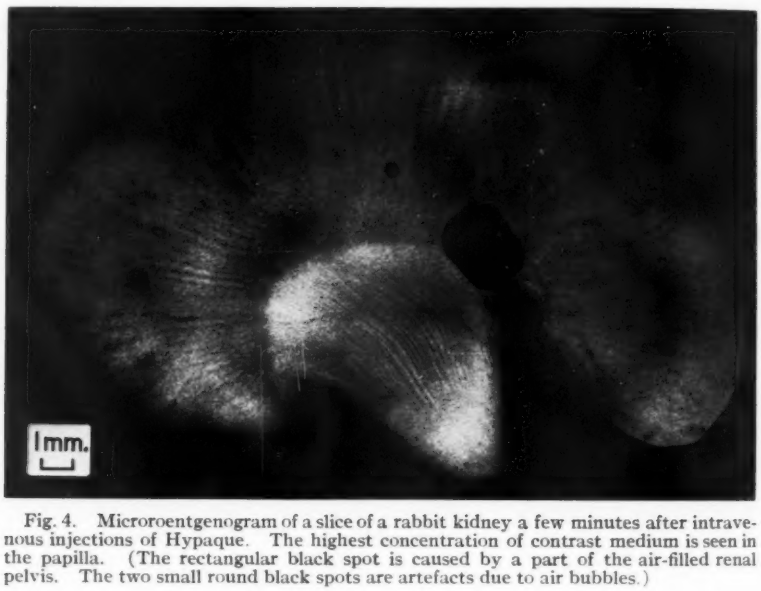

Fig. 4. Microroentgenogram of a slice of a rabbit kidney a few minutes after intravenous injections of Hypaque. The highest concentration of contrast medium is seen in the papilla. (The rectangular black spot is caused by a part of the air-filled renal pelvis. The two small round black spots are artefacts due to air bubbles.)

In the images obtained with the present technic, the radiopaque material appeared to be deposited mainly in the tubules. It was not possible to study the parenchyma between tubules in the microradiographs taken from thick sections.

DISCUSSION

These experiments demonstrate that the physiologic doctrine of final concentration of urine in the papilla of the mammalian kidney has its counterpart in Hypaque concentration in the rabbit kidney. Our microroentgenograms are very similar to Wirz's map of his cryoscopic findings (Figs. 3 and 4). There is no doubt that the final concentration in the collecting tubules is the explanation for the opacification of the papillae or "brushes" in clinical excretory urography.

A few further aspects of renal physiology connected with this problem are of roentgenologic interest and help in the understanding of the broad variations in clinical urography.

If a subject is deprived of water intake for twelve to eighteen hours, the body has a tendency to preserve its water reserve, to express it teleologically. Accordingly, release of antidiuretic hormone from the hypothalamic-hypophyseal system is stimulated *via* postulated osmo-receptors. Water is now maximally resorbed in the distal convoluted tubules, and the concentration operation in the collecting ducts becomes most effective. In a similar fashion, in excretory urography dehydration or hydropenia results in concentration not only of urine, but of contrast medium as well. Guided by these considerations, Bream successfully used Pitressin for improved concentration of the contrast medium in excretory urography.

In the absence of the antidiuretic hormone, reabsorption in the distal tubule of solutes, chiefly sodium and attendant anions, is accompanied by only a portion of water that would otherwise follow along the osmotic gradient established. This results in the delivery of a markedly hypotonic fluid to distal sites in such a quantity and at such a rate that the resorption in the collecting tubules of a quantity (absolute quantity) of solute-free water does not markedly diminish the volume or raise the concentration of the final urine (Strauss).

Between the optimum and minimum of antidiuretic hormone release and response there occur numerous intermediate stages. Correspondingly faint staining of the papillae may be recognized quite often if one has learned to look for it. Of factors which may alter the contrast concentration by increased or decreased release of antidiuretic hormone a few may be listed, according to Strauss: hydropenia, water deprivation, and excessive water drinking or hidden water deposits; morphine, barbiturates, and other drugs; emotion, hypnosis, hypoxia, hypercapnia, CO_2 inhalation, increased and decreased blood volume. It is not entirely clear what influence is exerted by the mode of excretion of the various contrast media. Diodrast (iodopyracet) and most of the earlier contrast media are filtered through the glomeruli and secreted by the tubules; Hypaque (sodium diatrizoate) and others are almost exclusively excreted *via* glomerular filtration (Lowman *et al.*, McChesney *et al.*). Moreover, the excretion of some contrast media may be interfered with by certain substances, such as penicillin, which presumably compete for the same tubular transport system.

The rate of tubular flow plays a part in governing water resorption, a slower flow permitting increased resorption. This would explain the frequent occurrence of "brushes" in patients with ureteral colic or external ureteral compression. It is not stagnation *per se*, but the slow flow rate, which permits increased water resorption in the papilla.

SUMMARY

The opacification of the papillae and pyramids in excretory urography is not due to a pyelotubular reflux. According to modern concepts of renal water metabolism, it can be explained by final water

resorption and concentration of urine in the collecting tubules and papillary ducts. The applicability of these principles of renal physiology to Hypaque injections was corroborated experimentally in rabbits. Opacification may occasionally be furthered by increased intrapelvic pressure. The roentgen appearance of the so-called "brushes" is not a sign of a morbid condition but is rather a reflection of normal renal function.

Finally, it should not be difficult to distinguish these appearances from tuberculosis, papillary necrosis, abscesses, or the rare heredofamilial disease of cystic tubular dilatation of the kidney sometimes designated as medullary sponge kidney (Lindvall).

Broader application of microroentgenography and autoradiography may be useful for studying several aspects of normal and disturbed renal function.

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SUMMARIO IN INTERLINGUA

Opacification Papillari in Urographia Excretori: Le Si-Appellate Refluxo Pyelotubular

Le opacification del papillas e pyramides in urographia excretori—le si-appellate opacification a "escappata de sol" o "brossiforme"—non es le resultato de refluxo pyelotubular sed pote esser explicate per le resorption final de aqua e le concentration de urina in le colligente tubulos e ductos papillari.

Le applicabilitate de iste principios de physiologia renal a injectiones de Hypaque esseva corroborate in experimentos con conilios. In certe casos le opacification pote esser promovite per un augmento de pression intrapelvic. Le configuration roentgenoscopic del si-appellate "brossas" non es le signo de un condition morbide sed plus tosto le reflexion del physiologia renal normal.

Il non deberea esser difficile distinguer inter iste configuration e illo de tuberculose, de necrosis papillari, de abscessos, o del rar morbo heredo-familial de dilatation cystico-tubular del ren que es designate a vices como ren a medulla spongiose.

Gastrointestinal Carcinoid Tumors

Roentgen Features[1]

IRWIN BLUTH, M.D.[2]

ISOLATED CASE reports and periodic reviews of the subject of carcinoid tumors have appeared in the medical literature for almost a century. The recent medical literature has been rich in papers dealing with the subject of carcinoid tumors due largely to the discovery of the malignant carcinoid syndrome as representing a clinical entity (1–12). The basic findings in this syndrome are chronic diarrhea, flushes and cyanosis, respiratory distress, and right-sided cardiac disease. The clinical syndrome has so far been described only in the presence of metastatic malignant carcinoids with large numbers of functioning cells, usually in the liver.

For detailed pathological data with reference to sites, multiplicity, incidence, age, sex, and metastases, the reader is referred to the work of Ritchie (9).

GROSS PATHOLOGY

The typical carcinoid tumor, which may occur in any portion of the gastrointestinal tract from the cardia to the anus, is a small submucosal nodule. Less often it is polypoid or annular in growth. The epithelium usually is intact, although occasionally it may be ulcerated. Infrequently, a large polypoid intraluminal growth occurs.

NATURAL HISTORY AND COURSE OF THE DISEASE

It is generally agreed that carcinoid tumors arise from the Kulschitsky cells. MacDonald (12) has suggested that all extra-appendiceal carcinoids be considered malignant and reported in terms of invasiveness. He has suggested that these tumors be classified pathologically into four groups:

Group 1: Non-invasive, confined to the mucosa and submucosa.

Group 2: Invading the bowel wall muscle.

Group 3: Invading the lymphatics or regional nodes.

Group 4: Invading blood vessels or spreading to distant organs.

Carcinoid tumors differ from most malignant neoplasms in the gastrointestinal tract, in the long duration of the disease. Long-term survivals, from one to two decades, are reported even in the presence of lymph-node involvement.

CARCINOIDS OF THE APPENDIX

Carcinoids located in the appendix are not detected by x-ray methods except in very rare cases with widespread metastases. Even then, the local lesion is not evident. When the source material consists of surgical specimens, the appendix is by far the most common site. Diffenbaugh and Anderson (13) reported metastases in 29 of 825 appendiceal carcinoids, an incidence of 3.5 per cent.

CARCINOIDS OF THE STOMACH

The previously cited review of 509 collected carcinoids from the literature (9) showed 9 in the stomach, an incidence of 2 per cent. Lattes and Grossi (14) report 5 cases of primary involvement of the stomach from the Columbia Presbyterian Medical Center from 1936 to 1955. During this period, the number of gastric tumors found was as follows: Carcinoma, 1,235; leiomyoma, 38; leiomyosarcoma, 17; lymphosarcoma, 34; adenoma, 31; carcinoid, 5. Recently, Pochaczevsky and Sherman (15) described the roentgen appearances of gastric carcinoids based on 3 new cases and 59 previously published.

Roentgenographic Findings: There are two roentgen findings characteristic of

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gastric carcinoids: (*a*) a small mass, sometimes with a shallow ulcer simulating the classical intramural, submucosal pattern, such as is seen with a myoma or even in adenoma (16, 17); (*b*) a large fungating mass simulating a polypoid carcinoma (Lattes and Grossi: Cases 2 and 5).

DUODENAL CARCINOIDS

Of the 500 carcinoids found in the literature by Ritchie (9) between 1934 and 1954, only 5 (1 per cent) involved the duodenum. Horsley and Golden (18) found 17 proved cases in the literature and added 2 of their own. Of the 19, only 3 had metastasized. Of the 15 patients in whom the tumor was a nonincidental finding at autopsy, 12 had symptoms. In 9, the symptoms were of partial duodenal obstruction. Brunschwig and Childs reported a possible carcinoid of the ampulla of Vater (19).

Roentgenographic Findings: The most frequent roentgen finding has been a small polyp in the first portion simulating such lesions as adenoma, myoma, pancreatic rest, lipoma, or prolapsed gastric polyp (20). (There is a single report of an infiltrating tumor obstructing the post-bulbar region.)

CARCINOIDS OF THE SMALL INTESTINE

As determined from autopsy findings rather than surgical specimens, the most common site of origin of carcinoids of the small intestine is the distal ileum. Less frequently they arise in the jejunum. Ritchie's review included 77 carcinoids in the ileum and 7 in the jejunum among 509 cases.

Roentgenographic Findings: The roentgen features of carcinoid tumors are closely related to their gross growth characteristics. Because carcinoids of the distal ileum are the ones which most frequently lead to metastases and subsequently to a malignant carcinoid syndrome, this site should receive the most attention in a search for the primary lesion. The roentgen findings may be enumerated as follows:

1. Intestinal Obstruction: The tumor seldom is of sufficient size to cause mechanical obstruction. The small primary tumors that extend through the bowel wall and produce infiltrating masses in the adjacent mesentery have led to the formation of adhesions which can result in chronic partial obstruction and less often to acute complete obstruction. This implies that obstruction of the small intestine in the presence of a carcinoid tumor indicates at least local malignancy. This behavior of the tumor was the basis of the report by Miller and Herrmann (22) in which they pointed out that a kinked bowel demonstrated with barium, associated with a small asymmetrical filling defect (the tumor component), is a highly suggestive finding. Occasionally, the intraluminal type may produce an intussusception. Fibrous annular constriction of the bowel is another occasional cause of obstruction.

2. Polypoid Filling Defect: A polypoid filling defect may be seen within the lumen of the small intestine. It is best illustrated by Case II, below.

CARCINOIDS OF THE COLON

In Ritchie's review, 18 (4 per cent) of the 509 collected carcinoids were found in the colon, excluding the rectum. Since most of the reported cases are in the proximal right colon, it is safe to assume that most malignant carcinoids occur within a short distance of either side of the ileocecal valve, but with a great predilection for the ileal side (23).

Roentgenographic Findings: The roentgen findings are: (*a*) a large polypoid intraluminal mass similar to a primary adenocarcinoma; (*b*) large-bowel obstruction due either to the size of the mass, infiltration of an annular nature, or intussusception.

RECTAL CARCINOIDS

Rectal carcinoids are of no radiological significance. They are usually small submucosal nodules (24), 1 cm. or less in diameter. The most common site is the anterior wall of the rectum. These tumors

do not reduce silver salts. They can metastasize. Lamphier and Ehrlich (25) reviewed 212 cases from the literature and added 6.

CASE REPORTS

CASE I: L. M., a 62-year-old white male, was first admitted to Beth-El Hospital on April 5, 1958, complaining of diarrhea of six months duration. At the time of admission, he was having ten movements per day, of watery consistency, with no blood or mucus. At about the time of onset, he had noticed that his face occasionally became flushed. There had been a weight loss of about 14 pounds over the preceding year. An appendectomy had been performed seven years earlier at a different institution.

Physical examination revealed a marked flushing of the face and neck, chest, and back. The temperature was 98.6°, pulse 76, respirations 20, blood pressure 165/95. No cardiac murmurs were heard, and the heart was not enlarged. Râles were heard over the bases of both lungs posteriorly. The liver was enlarged to a handbreadth below the costal margin. It was irregular.

The urine was essentially normal. A complete blood count showed 13.5 gm. hemoglobin and 7,700 white cells. On several occasions the 5HIAA test in the urine was strongly positive.

Roentgenographic Findings: A gastrointestinal series and small intestinal study revealed evidence of extrinsic pressure on the medial wall of the stomach above the cardia (Fig. 1). Hypermotility was extreme; in one hour, the barium outlined the small bowel and colon to the rectum. The liver was obviously enlarged.

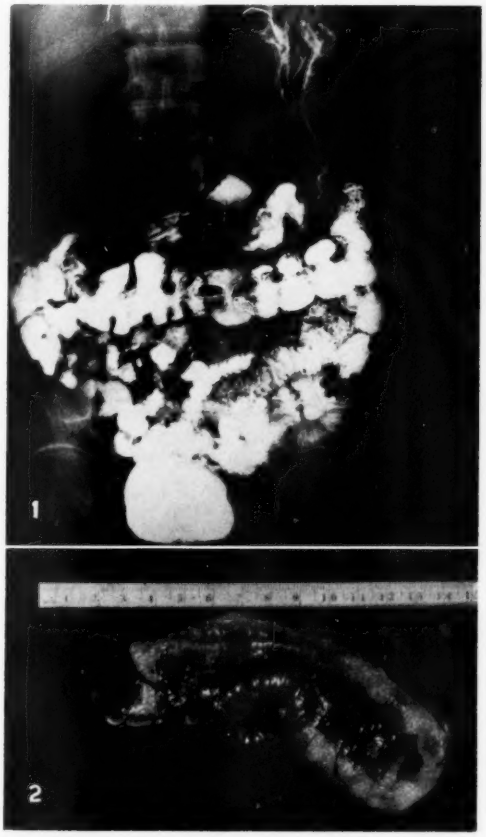
Surgery: On April 18, 1958, a 6-inch segment of ileum was resected. "There was a small nodule about 6 mm. in diameter on the mesentery side of the ileum, about 2 feet from the ileocecal junction. Both lobes of the liver were studded throughout with metastases." A liver biopsy was done.

Pathology: The surgical specimen consisted of a segment of small intestine measuring 4 × 5 × 1 cm. On the mucosa was a node measuring 1 × 1 × 0.5 cm., yellow on section and infiltrating through the entire wall of the specimen (Fig. 2). Intracytoplasmic argentophil granules were present.

Diagnosis: Primary carcinoid of the small intestine and secondary carcinoid in the liver.

The patient was discharged May 6, eighteen days postoperatively, with no change in symptoms.

Discussion: This is a classical case. The disease had probably been present many years, being almost completely asymptomatic. The primary lesion remained extremely small and gave no direct evidence of its presence on roentgenograms of the gastrointestinal tract. With progressive hepatic metastasis and increasing levels of serum serotonin, the malignant carcinoid syndrome appeared, suggesting a clinical diagnosis. It was felt that the extrinsic gastric indentation was from an hepatic metastasis.



Figs. 1 and 2. Case I. Fig. 1 is a postero-anterior film made one hour after oral ingestion of barium. The extreme motility is indicated by the fact that the head of the barium column has already reached the rectum. There is an extrinsic pressure defect in the region of the cardia of the stomach, due to a metastatic nodule in the liver. There is no evidence of the primary lesion, which was situated in the ileum.

The surgical specimen reproduced in Fig. 2 shows the primary tumor, which was situated in the distal ileum. The growth through the serosa is classical for carcinoid tumors at this site.

CASE II: A 72-year-old white male was admitted on Jan. 19, 1954, complaining of progressive weakness and loss of weight. He had been well until seven months prior to admission, when he had a severe gastrointestinal hemorrhage and was hospitalized. He was given 5 pints of whole blood and

Fig. 3. Case II. Postero-anterior film made two hours after the oral ingestion of barium. Within a loop of ileum in the right lower quadrant there is an obvious defect, widening the lumen, producing multiple polypoid impressions, and containing ulcerated areas. It is believed by the author that this is the first reported case of a carcinoid tumor producing this type of change.

was told that he had a gastric ulcer. There had been a progressive weight loss of 25 pounds over three to six months. According to the patient's statement, he had experienced an attack of extreme weakness four weeks before admission, accompanied by gastrointestinal bleeding.

On physical examination the patient appeared weak. His blood pressure was 190/100; pulse, 76; respirations, 20. There was a rough precordial systolic murmur, with A2 greater than T2. The liver was palpable one finger breadth below the costal margin.

The urine was essentially normal. A complete blood count on Jan. 20 showed hemoglobin 5.1 gm., red cells 1,960,000.

Roentgenographic Findings: A gastrointestinal series on Jan. 25 disclosed a slight hiatus hernia. The bulb was irregular in outline and distorted. A small bowel study on Feb. 8 revealed a 9-cm. widened segment of ileum which contained numerous polypoid defects (Fig. 3).

Surgery: Operation was performed on Feb. 17. According to the surgeon's report, "there was a large neoplastic mass infiltrating the region of the jejunoileal junction, involving several inches of small gut, with edema of the mesentery for several inches on each side. Two small nodes were felt in the mesentery adjacent to the involved gut. The liver appeared normal." The mass was excised and an end-to-end anastomosis was performed.

Fig. 4. Case II. Close-up view of the gross specimen. The findings parallel the roentgen observations closely. Note the widened lumen, polypoid changes, and ulcerated area within the tumor.

Pathology: The specimen was an 80-cm. segment of ileum (Fig. 4), at the center of which was a mass measuring 7 × 5 cm. This protruded into the lumen and the mucosa was ulcerated. Polypoid projections were present. There was hemorrhage on the surface of the ulcerated area. Microscopically the lymph nodes appeared normal. The histologic diagnosis was carcinoid with ulceration. Intracytoplasmic argentophil granules were present.

Course in the Hospital: The patient did well for four days and then lapsed into anuria, became comatose, and died in forty-eight hours.

Discussion: This case is rather atypical for carcinoid tumor of the ileum. From a survey of the literature, it appears to be the first case reported in which roentgen examination revealed a large polypoid mass in the ileum, widening the lumen, proved histologically to be a carcinoid. Only infrequently do carcinoid tumors of the ileum grow toward the lumen rather than toward the serosa. The ulceration of the tumor with hemorrhage probably accounted for the anemia. This, too, is unusual, since the occasional intraluminal carcinoid does not usually ulcerate. The growth toward the lumen and associated anemia probably resulted in an earlier diagnosis in this instance than is usually made, as evidenced by an absence of any remarkable distant metastases. Polypoid intraluminal carcinoids have been reported in the colon and stomach.

CASE III: M. B., a 71-year-old white male, was admitted on May 5, 1955, complaining of intermittent cramps in the right lower quadrant for four

Figs. 5 and 6. Case III. Fig. 5 is an oblique view of the barium-filled colon. In the proximal portion of the transverse colon there is an intussusception.

Fig. 6. A photograph of the specimen with the colon opened, reveals the polypoid tumor within the lumen.

to five weeks. The attacks had occurred practically every day. During this time the patient experienced nausea, dizziness, and spells of vomiting. There had been a 4-pound weight loss over four weeks. Two operations had been performed, thirty years earlier, one for a benign intrapelvic tumor and a herniorrhaphy.

The blood pressure was 144/88; pulse, 86; temperature, 100.6°. The patient was malnourished, with flushed face and erythematous patches over the chest. There was a mass in the midabdomen above the umbilicus and to the right.

The urine was negative. Hemoglobin was 13.6 gm.; the white blood count 7,400.

Roentgenographic Findings: A barium enema examination on May 9 revealed an obstruction in the proximal transverse colon due to intussusception (Fig. 5). Compression spot-films outlined a polypoid mass at the head of the intussusception.

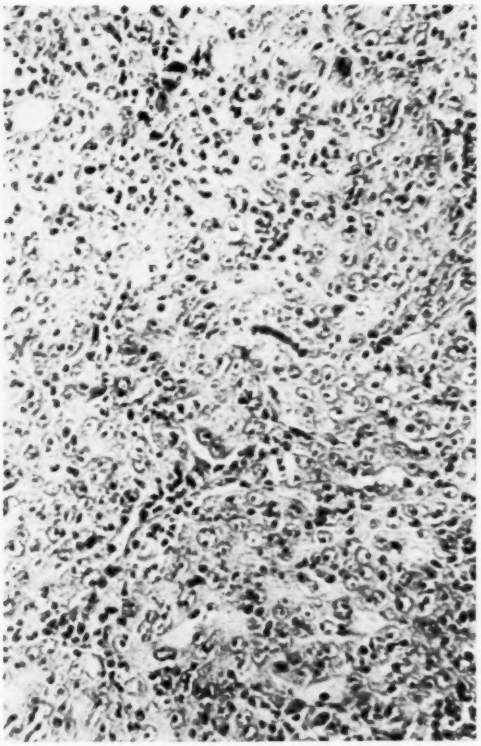


Fig. 7. Case III. Photomicrograph showing the microscopic structure of the tumor.

Surgery: At operation there was found to be an intussusception of the ascending colon and hepatic flexure into the proximal transverse colon, with a large infiltrating mass in this region. Several nodules were palpable deep within the liver, and there was much seeding along the mesentery. A right hemicolectomy was done.

Pathology: About 10 cm. above the ileocecal valve was a hard, palpable, nodular mass measuring 5 × 4.5 cm. in its widest diameters (Fig. 6). At this site the upper portion of the lower segment of the ascending colon penetrated into the lower pole of the upper segment and formed a true intussusception. Upon section, there was a yellow-pinkish mass of firm tissue protruding into the lumen of the colon, completely encircling the wall and partially obstructing it. The lymph nodes were firm. The microscopic diagnosis was carcinoid tumor (Fig. 7). Intracytoplasmic argentophil granules were present.

Course in the Hospital: The patient made an uneventful recovery and was discharged on the twelfth postoperative day.

Discussion: Although no 5HIAA test

Fig. 8. Case IV. Filling defect within the barium-filled sigmoid colon.

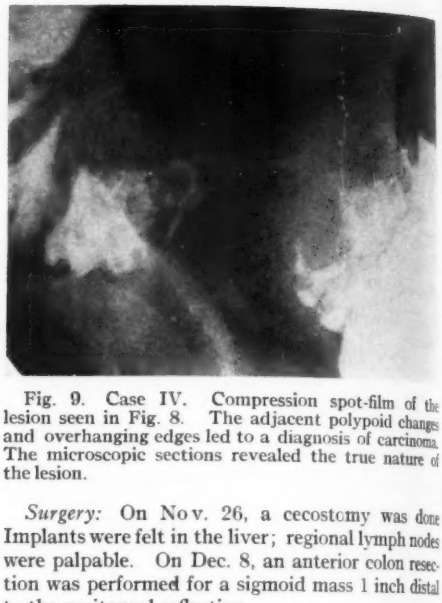


Fig. 9. Case IV. Compression spot-film of the lesion seen in Fig. 8. The adjacent polypoid changes and overhanging edges led to a diagnosis of carcinoma. The microscopic sections revealed the true nature of the lesion.

was done, a description of the facial flush certainly suggests the probability of the serotonin effect. The colon is not a common site of carcinoids, but those which do occur have a predilection for the cecum and ascending colon. As mentioned earlier, the colonic carcinoids present as intraluminal polypoid masses and thus can lead to intussusception. This case therefore exhibits the typical appearance of an infrequent lesion.

CASE IV: C. M., a 57-year-old white male, was admitted on Nov. 13, 1954, with a history of constipation for five days, severe lower abdominal pain for two to three weeks, and blood appearing after bowel movements for four to five weeks. The pain appeared intermittently during the day and night but was of only a few minutes duration.

Blood pressure was 150/80. There was a systolic murmur at the apex. A mass was felt in the left lower quadrant. Sigmoidoscopy revealed an area of induration at 4 1/2 inches, with a polypoid protrusion in the left anterior quadrant. The biopsy report was adenocarcinoma.

Roentgenographic Findings: A barium enema examination on Nov. 17 revealed canalization of the distal sigmoid involving an area 4 cm. in length (Fig. 8). There were polypoid changes in the mucosa at this site (Fig. 9). The lesion did not have the appearance of a classical "napkin-ring," but rather there was narrowing due to a mass growing into the lumen and producing an eccentric narrowing superiorly.

Surgery: On Nov. 26, a cecostomy was done. Implants were felt in the liver; regional lymph nodes were palpable. On Dec. 8, an anterior colon resection was performed for a sigmoid mass 1 inch distal to the peritoneal reflection.

Pathology: The specimen was a 15-cm. segment of colon, at one end of which was a circular scirrhous polypoid-like lesion encircling and almost obliterating the lumen of the colon. The microscopic diagnosis was carcinoid of the colon, and secondary carcinoid of the lymph nodes. Intracytoplasmic argentophil granules were present.

Subsequent Course: The patient was discharged on the fourteenth postoperative day. He was readmitted Feb. 28, 1955, with abdominal pain and distention. X-ray examination revealed distention of the colon, and a transverse colostomy was done on March 8. Death occurred March 15.

Autopsy Findings: At autopsy there was found malignant carcinoid involvement of the entire pelvis, with secondary deposits in the liver, nodes, pancreas, and diaphragm. There was also secondary carcinoid in the lungs, involving perivascular and peribronchial lymphatics. The surface of the tricuspid valve and right ventricular endocardium showed fibrosis.

Discussion: Autopsy in this case revealed changes in the heart which we now attribute to the effect of excessive serum serotonin. The x-ray findings could in no way be differentiated from classical adenocarcinoma of the sigmoid. This case serves to indicate how difficult a problem it is to diagnose carcinoid tumors, particularly when remote from the ileocecal region.

SUMMARY

The subject of carcinoid tumors of the gastrointestinal tract has been reviewed, and attention has been called to the malignant carcinoid syndrome, consisting of chronic diarrhea, flushing and cyanosis, respiratory distress, and right-sided cardiac disease.

It has been suggested that all gastrointestinal carcinoids except those of the appendix be regarded as malignant. They differ from other malignant neoplasms of the digestive tract in their long duration.

The usual site is in the ileum, within a few feet of the ileocecal valve. It is carcinoids in this location which most frequently metastasize and eventually lead to the carcinoid syndrome. Carcinoids occur also in the appendix, stomach, duodenum, jejunum, colon, and rectum. Appendiceal and rectal carcinoids are not of radiologic significance. The roentgen findings for the other sites are described. The chief features are a polypoid mass and some degree of obstruction.

Four cases are reported. In one of these the tumor was intraluminal, widening the caliber of the involved ileal segment. This represents an unusual growth pattern for carcinoid of the ileum, as the growth is usually in the direction of the serosa.

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SUMMARIO IN INTERLINGUA

Tumores Carcinoide del Vias Gastrointestinal: Aspectos Roentgenoscopic

Es presentate un revista del tumores carcinoide del vias gastrointestinal. Es signalate le si-appellate maligne syndrome carcinoide, consistente de diarrhea chronic, fluxion e cyanosis, angustia respiratori, e morbo cardiac dextero-lateral.

On ha suggerite que omne carcinoides, con le exception de illos del appendice, debe esser considerate como maligne. Tamen, illos differe de altere maligne neoplasmas gastrointestinal in le longor de lor duration. Lor sito usual es in le ileum intra pauc pedes del valvula ileocecal. Il es le tumores in iste location que resulta e plus frequentemente in metastases, con le resultato—in le curso del tempore—del maligne syndrome carcinoide. Le occurrentia de carcinoides es etiam possibile in le appendice, le stomacho, le duodeno, le jejuno, le colon, e le recto. Le constatationes roentgenologic pro omne iste sitos es describite. Le aspectos le plus commun es un massa polypoide e obstruction.

Es reportate quatro casos. In un de istos le crescentia esseva intra le passage, allargante le calibre del afficite segmento ileal. Isto representa un configuration inusual del crescentia de un carcinoide del ileum. Le configuration usual es crescentia verso le serosa.

Simple Distal Ileal Obstruction[1]

BERNARD S. EPSTEIN, M.D.

ABDOMINAL distention, persistent cramps, vomiting, and exaggerated peristaltic activity often lead to the diagnosis of small-intestinal obstruction. Visualization of gaseous and fluid dilatation of the lesser bowel and absence of gas in the colon on scout roentgenograms are generally regarded as confirmatory evidence. While reliable in many patients with acute obstruction, these criteria are not necessarily applicable to the diagnosis of distal ileal block. This may be produced by inflammatory adhesions from such diverse conditions as appendicitis, pelvic inflammatory disease, diverticulitis and postoperative or congenital bands. Regional ileitis, small-intestinal lymphomas, and granulomas also cause ileal stenosis. Intraluminal and extrinsic neoplasms, endometriosis, and various hernias are additional factors.

The present study of the radiological aspects of simple ileal obstruction was undertaken to assess the diagnostic value of scout films and contrast examinations of the gastrointestinal tract. Observations were made on 14 patients, 5 men and 9 women from thirty to seventy years old. Symptoms, often ill defined, had been present for two weeks to more than seven years. These consisted of intermittent borborygmi, mild or sometimes severe abdominal cramps, nausea, distention, and occasional regurgitant vomiting. Successive bouts of diarrhea occurred in 2 patients. One had been treated for sprue for more than three years because of steatorrhea and a small-intestinal deficiency pattern on repeated radiographic examinations. Complaints frequently were attributed by physician and patient to such causes as emotional disturbances, virus attacks, dietary indiscretions, and allergies. Frequent intervals of complete absence of discomfort were noted by some patients with long-standing complaints. Four patients had persistent symptoms of fluctuating intensity continuously for about two weeks.

Physical examination frequently revealed few or no significant changes. Visible peristalsis and abnormal bowel sounds were noted from time to time in 4 patients, and were fairly persistent during periods of severe symptoms. Moderate distention was present in 6 patients with mild distress. In 11 no gross abnormalities in the passage of gas or stool were evident. Three had diminished bowel activity for several days. While no definite abdominal masses were palpated, the admission diagnosis in 3 instances included the possibility of ovarian cysts because of distended fluid-filled ileal loops in the pelvis.

Intestinal obstruction was the admission diagnosis in 5 patients and was considered likely in 3 others. In 5 ileal obstruction was suggested mainly by the radiologic observations. In 1 case the diagnosis was not made until operation disclosed a gastric carcinoma with extrinsic pelvic peritoneal metastases causing ileal stenosis. A review of the gastrointestinal films showed that the dilated ileum had been misinterpreted as an elongated and distended sigmoid.

Scout roentgenograms of the abdomen were made immediately after admission in 12 patients. In 5, no significant lesser bowel dilatation was found initially. Four had moderate gaseous distention which was considered to represent ileus because gas was present in the jejunum, ileum, and colon. The remaining 3 had definite small-intestinal ladder patterns with fluid levels consistent with the diagnosis of lesser-bowel obstruction. Gas and feces were observed in the colon in 11 patients. The configuration and location of the gas- and fluid-filled loops were

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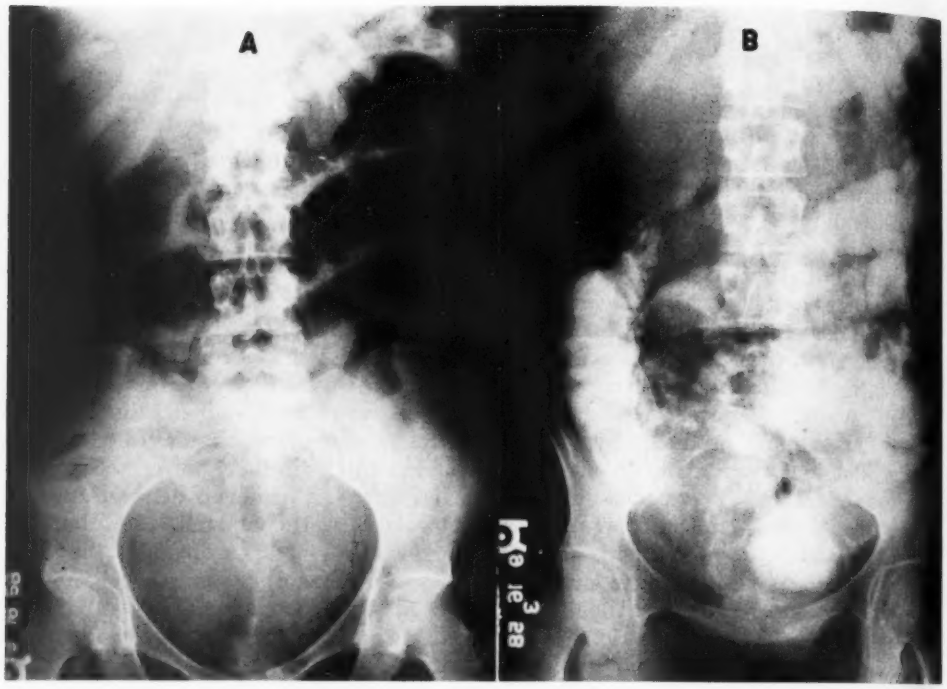

Fig. 1. D. E., a 34 year-old woman with bilateral tubal abscesses and partial ileal obstruction.
A. Scout abdominal film revealing distended small intestine in the upper abdomen. The pelvis contains loops of fluid-distended ileum. Gas is present in the colon.
B. Three hours after ingestion of 60 c.c. of Hypaque. The water-soluble medium persists in the dilated jejunum and ileum. Some has entered the ascending colon. An indentation is seen along the medial wall of the cecum.

variable as delineated on successive scout films made over a period of two to five days in 10 patients. In 4 the fluid-filled ileal loops were identified as faintly opaque densities in the right lower and midabdomen. In 2 of this latter group, scout films made about five hours apart showed that the fluid in these loops was replaced by gas; in the other 2, changes occurred in the position and caliber of the distended ileum. Persistent mottling due to gas and fluid distention was observed in 4 patients. In 3 of these the diameter of the ileum approached or exceeded that of the colon, making it difficult to decide from the scout films whether the shadow represented ileum, right colon, or sigmoid. In most

C. Five hours after ingestion of Hypaque. The cecal deformity is more apparent. There is still contrast material in the distended ileum. At operation the terminal ileum was kinked and partially obstructed by a tubal abscess which impinged against the cecum.

Fig. 2. S. M., a 70-year-old man with partial intestinal obstruction due to trapping of the distal ileum in adhesions at an incisional hernia.

A. Erect abdominal roentgenogram one hour after oral administration of 60 c.c. of Gastrografin. The jejunal and proximal ileal loops are dilated and there is a large amount of gas in the colon.

B. Three hours later. The contrast medium outlines markedly dilated lesser bowel, and some has entered the ascending colon.

patients the appearance of the valvulae conniventes was inconstant, particularly in the presence of transient variable jejunal and proximal ileal dilatation. While the site of obstruction could not be ascertained with certainty from the scout films, a persistently dilated ileum containing gas and feces can be regarded as evidence of distal ileal block. This sign may vanish, however, if the dilated ileum empties itself into the colon, which renders it of dubious value in some cases.

Seven patients were given a barium meal. Three others had both barium studies and examinations with water-soluble contrast media, about 60 c.c. of either Hypaque or Gastrografin orally. In 4, examinations with water-soluble contrast material alone were satisfactory, making further barium study unnecessary. No gastric or duodenal disturbances were found. Considerable variability in the appearance of the jejunum was observed. Prominent dilatation was present in 6 patients, 3 of whom had relatively severe symptoms. In those with voluminous small-bowel dilatation the various loops could not be identified adequately without contrast material but were readily recognized with water-soluble media, which have a considerably more rapid transit time through the small bowel than barium (1).

Partial ileal obstruction was diagnosed when a water-soluble medium was retained in the dilated distal small bowel for more than three hours. The entrance of the contrast material into the colon did not exclude the presence of partial obstruction. In some the lesser bowel remained persistently distended with gas even though emptied of the medium within six to twenty-four hours. The possibility of

combined partial obstruction and physiologic ileus was thought of in these patients. The entrance of Hypaque or Gastrografin into the colon served to identify that organ. It was remarkable how often the diameter of the ileum exceeded that of the colon.

Not only does barium pass more slowly through the small intestine than Hypaque or Gastrografin, but with lesser bowel dilatation the transit time may be further prolonged. Both barium and the water-soluble materials become diluted in the fluid-filled ileum proximal to an obstruction. A blunted or linear deformity of the bowel sometimes indicates the site and nature of the obstruction. Compression spot-films help bring this out. In some cases, however, the anatomic location cannot be distinguished because the normal disposition of the loops is altered considerably when the intestine is dilated and elongated. We were able to identify the location of the obstruction accurately in but 5 patients in the present series. In a previously reported case (2) included in this series, foreign bodies were outlined by barium in a dilated ileum.

When necessary, adequate visualization of the large bowel was obtained with enemas of either Hypaque or Gastrografin, with the advantage of avoiding the possibility of barium impaction. In some patients water-soluble media orally and by enema permitted satisfactory demonstration of the entire gastrointestinal tract within two or three hours. If such survey studies were inadequate, barium examinations were undertaken without delay. It should be mentioned that in over 200 patients examined with water-soluble materials no ill effects other than occasional mild diarrhea were noted. Somewhat contrary to a previous impression that these substances are virtually unabsorbable, we have since noted indications of absorption in the form of faint visualization of the bladder in 10 patients and of the renal pelvis in 5.

Barium-enema examinations were normal in 4 patients, as were water-soluble contrast enema studies in 3 others. In one woman with bilateral tubal abscesses, extrinsic pressure on the cecum was demonstrated by both Hypaque and barium enemas as well as on gastrointestinal study within sixty minutes after swallowing Hypaque.

All 14 patients were operated upon. Ileal obstruction was found to be caused by postoperative bands and kinking due to adhesions in 4. One woman had adhesive bands without known cause. The bowel proximal to the obstruction was dilated and moderately hypertrophied in 2. In 2 others the dilatation was more pronounced and the bowel wall was thinned. In the fifth patient the obstruction had been relieved before operation for an incisional hernia. Inspection of the bowel at operation disclosed no visible changes.

Stenotic ileitis was the cause of intermittent distal ileal obstruction in 5 patients. In 4 the lesion was limited to the terminal 15 cm. of small intestine. In 1 case a skip area about 5 cm. long was seen between two involved segments approximately 7 and 5 cm. long. The remainder of the small intestine showed no visible evidence of regional enteritis at operation. The dilated bowel proximal to the stenotic ileitis was about four to five times the normal thickness and had well preserved and thickened mucosal folds. The jejunum in these patients was dilated but not hypertrophied.

Neoplastic disease causing extrinsic pressure and partial obstruction of the ileum was found in 3 cases. An intrinsic ileal carcinoma caused intermittent obstruction in 1 patient in whom the admission diagnosis had been ovarian cyst because of the dilated ileal loop palpated in the pelvis. The small intestine proximal to the obstruction was hypertrophied and dilated in 3 patients, and approximately normal in 1.

COMMENT

The clinical and radiologic identification of simple small bowel obstruction depends mainly on the location, rate of progression, and the persistence of the block. Inter-

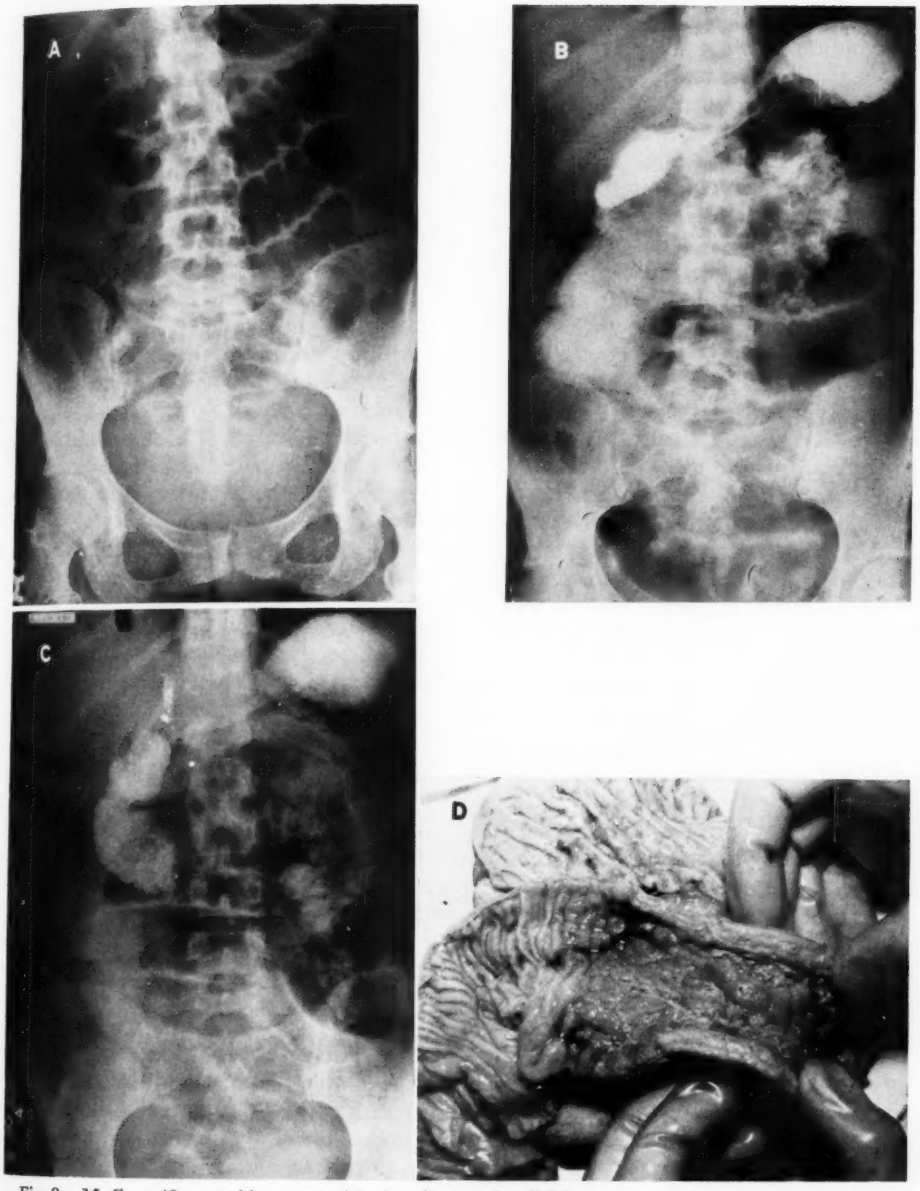

Fig. 3. M. G., a 40-year-old woman with chronic stenosing ileitis.

A. Scout film revealing dilated loops of lesser bowel arranged in a ladder pattern in the midabdomen. The pelvis contains several loops of fluid-distended small intestine. Occasional bubbles of gas are present in the colon.

B. Two hours after ingestion of 60 c.c. of Gastrografin. Much of the contrast material remains in the stomach, but sufficient has passed into the small intestine to delineate the proximal jejunal loops in a fairly normal pattern. The distal jejunum and the proximal ileum are dilated. Note that the loops of small intestine in the pelvis are now distended with gas.

C. Four hours after ingestion of Gastrografin. The duodenal loop is dilated. The density of the opaque medium is less than on the previous film. However, the distal ileum is now sufficiently opacified for identification of a point of block in the right lower quadrant.

D. Operative specimen showing thickening of distal ileum due to stenosing ileitis. Note that the mucosal folds of the ileum proximal to the lesion are heavy, and that the ileum is dilated and thickened.

mittent vague symptoms, or none at all, are encountered when adequate passage of the intestinal contents takes place. Radiologic investigation during this phase often is not helpful. Sudden cessation in the movement of the intestinal current causes more pronounced symptoms, particularly with high and rapidly progressive block. Similar lesions in the ileum tend to be accompanied by less colic, vomiting, and peristaltic overactivity. The entire picture of both high and low small-bowel obstruction becomes exaggerated when complications incident to rotation and strangulation supervene.

Progressive simple ileal obstruction frequently is unsuspected until the intestinal current is sufficiently blocked to cause symptoms. This often occurs intermittently, so that attacks are forgotten, only to be recalled during recurrences. Many patients have adequate gas and stool evacuations for some time before the obstruction causes frequent episodic or uninterrupted distress. At operation, the bowel proximal to the obstruction is found to be hypertrophic and dilated in those patients with slowly progressive ileal block such as occurs with stenosing ileitis and less often with inflammatory adhesions. With sudden unrelieved block, the bowel becomes dilated and thinned.

Scout roentgenograms have long been regarded as important in the diagnosis of intestinal obstruction. However, these do not always provide accurate information (3). Differentiation of mechanical from paralytic ileus cannot be made with certainty because of lesser bowel dilatation, fluid levels, and absence of colonic gas. Neither can one rely on the appearance of the valvulae conniventes in deciding whether or not vascular impairment of the bowel is present, particularly with partial distal ileal obstruction. Scout films often are normal when ileal obstruction is not symptom-producing. When symptoms are present, a wide variation exists in the patterns of the small and large bowel, and both often contain considerable gas. In some patients gas and fluid distention of the ileum offers a clue to the diagnosis. The use of contrast material provides welcome help. Frimann-Dahl (4) has long favored barium examinations for the diagnosis of partial intestinal obstruction, regarding possible bowel perforation as perhaps the only contraindication. Donato, Mayo, and Barr (5) found that barium tended to remain fluid when confined to dilated bowel proximal to obstructions created by encircling the terminal ileum in dogs with cellophane. Nevertheless, barium may become impacted after entering the large intestine. We have found examinations with about 60 c.c. of water-soluble material useful (6). Films made at suitable intervals permit identification of the intestinal loops quickly and fairly accurately.

The difficulty in distinguishing between mechanical ileal block and paralytic ileus must not be underestimated. Indeed, this is almost impossible in some stages of partial obstruction if the contrast materials reach the colon rapidly. If water-soluble material is retained in dilated ileum for more than three hours, partial obstruction should be suspected even though some of the medium enters the colon. If the contrast material is entirely within the colon and the lesser bowel remains dilated, the possibility of either paralytic ileus, mechanical partial obstruction, or a combination of the two, indicates the need for further observation.

SUMMARY

Radiologic observations on 14 patients with simple distal ileal obstruction are reviewed. Slowly progressive ileal block is accompanied by variable intermittent symptoms which are exacerbated when the block becomes pronounced and relieved when the flow of intestinal contents is restored. The small bowel in these patients becomes distended and hypertrophied, to such an extent that the dilated ileum may attain a thickness and diameter greater than that of the colon. This is in contrast to the thinning of dilated small intestine observed with sudden and relatively com-

plete block. Scout roentgenograms are rather deceptive. Both barium studies and examinations with water-soluble contrast media (Hypaque and Gastrografin) were found helpful in investigations for ileal obstruction.

NOTE: Oral Hypaque was supplied by the Medical Research Department of Winthrop Laboratories. Gastrografin was supplied by The Squibb Institute for Medical Research.

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SUMMARIO IN INTERLINGUA

Simple Obstruction Ileal de Sito Distal

Es presentate un revista del observationes radiologic in 14 patientes con simple obstruction ileal de sito distal. Un lentemente progressive bloco ileal es accompaniate de variabile symptomas intermittente que es exacerbate quando le bloco deveni pronunciate e alleviate quando le fluxo del contento intestinal es restaurate. Le intestino tenue in iste patientes es distendite e hypertrophiate a un tal grado que le dilatate ileum attinge possibilemente un spissitate e un diametro plus grande que le colon. Isto contrasta con le tenuification del dilatate intestino tenue que es observate in bloco subite e relativemente complete. Roentgenogrammas probatori es satis deceptive. Studios a barium e studios a medios de contrasto solubile in aqua (Hypaque e Gastrografina) se ha monstrate utile.

Wandering of the Retrocardiac Esophagus: A Pitfall in the Diagnosis of Left Atrial Enlargement[1]

HAROLD D. BATT, M.D.[2]

CONTRAST visualization of the esophagus is widely used as an aid in evaluating the posterior mediastinal structures and cardiac chambers. The value of this examination is so well recognized that certain esophageal displacements have assumed diagnostic importance. The purpose of this paper is to call attention to a small group of patients in whom the usual radiographic appearances may be misleading because the retrocardiac esophagus is unusually mobile and able to wander to either side of the midline.

In order to appreciate this situation, it is pertinent to consider briefly the anatomy which makes it possible. The esophagus has no true serosa, its outer muscular coat being covered with connective tissue loosely continuous with adjacent structures. The cricopharyngeus muscle and cricoid cartilage fix the esophagus in its upper part. As it descends, fibro-elastic tissue and small muscle fibers are found between it and the trachea. More inferiorly, small muscle fibers may also pass to the pleura, left bronchus, and posterior surface of the pericardium. Laterally, the pleural reflections form a border which is not fixed. The arteries which arise from the aorta and pass to the esophagus are unpaired and form a continuous anastomotic chain. The most distal esophagus receives ascending branches from the left gastric artery. That these tenuous attachments do not restrict mobility of the retrocardiac esophagus may be readily confirmed by observing the normal pendulum motion of the distal esophagus during barium swallow. In the frontal projection, on deep inspiration, the esophagus descends in a straight path and on expiration is commonly displaced slightly to the right of the midline by the normal left auricle. This to-and-fro motion is slightly more marked in the stocky individual. On the other hand, when the retrocardiac esophagus is abnormally mobile, the appearance on barium swallow can simulate left atrial enlargement and cause the radiologist to reach a false conclusion. Cases I and II illustrate this point.

CASE I: An 82-year-old white woman was admitted to the hospital in April 1954, with unresolved pneumonia, hypertensive cardiovascular disease, and congestive heart failure. The pneumonia gradually resolved, but the heart failure did not respond to treatment.

Initial x-ray studies revealed apparent displacement of the distal esophagus posteriorly and to the right. This was thought to indicate left atrial enlargement, and a radiological diagnosis of mitral valve disease was made. Follow-up roentgenograms showed the distal esophagus to be mobile and able to wander to either side of the midline (Figs. 1 and 2). This could be demonstrated by rolling the patient up on one side. Under these circumstances, the barium-filled esophagus would move to the dependent side and remain there when the supine position was resumed. On one occasion, when the esophagus was noticed to be in the midline, inspiration and expiration films were made in the supine position without dislodging it. At no time was the left lateral displacement observed to go beyond the medial border of the heavily calcified descending aorta. In this patient, the esophagus crossed the aorta at the level of the eleventh dorsal vertebra.

The patient died in June 1954. At autopsy, the heart weighed 405 gm. and the mitral valve was normal. The aortic valve showed calcification of the cusps with moderate stenosis. The left atrium was normal in size. Both pleural cavities were free of adhesions except for the apex on the right side. No esophageal abnormalities were noted.

CASE II: A 71-year-old white male was admitted to the hospital because of abdominal pain and congestive heart failure in January 1957. Initial and follow-up x-ray studies revealed some cardiac enlargement and esophageal mobility similar to that observed in Case I. An erect lateral chest film obtained following a barium swallow revealed no true posterior displacement of the esophagus. Furthermore, there was no clinical evidence of mitral valve disease.

[1] Accepted for publication in June 1959.

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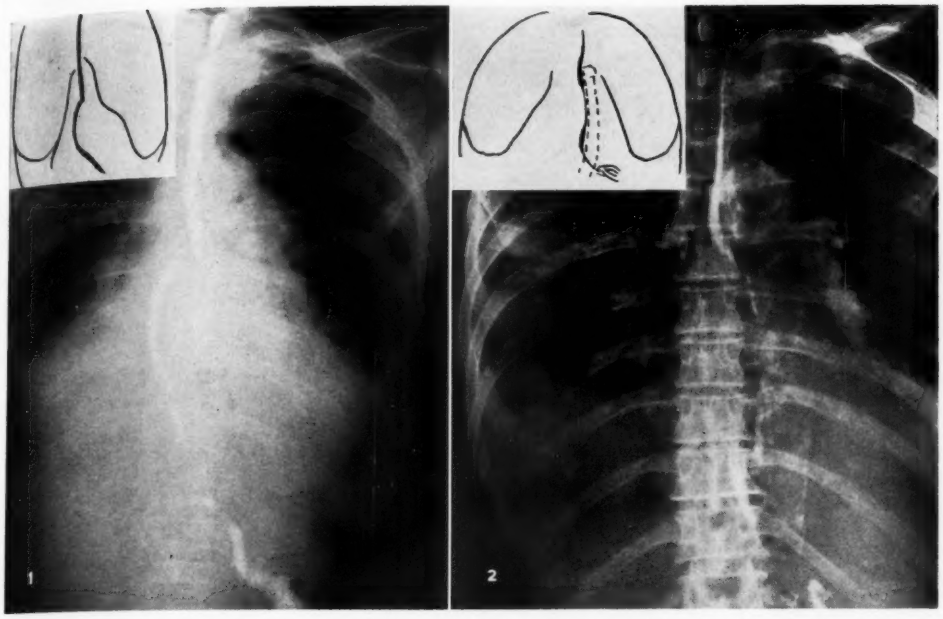


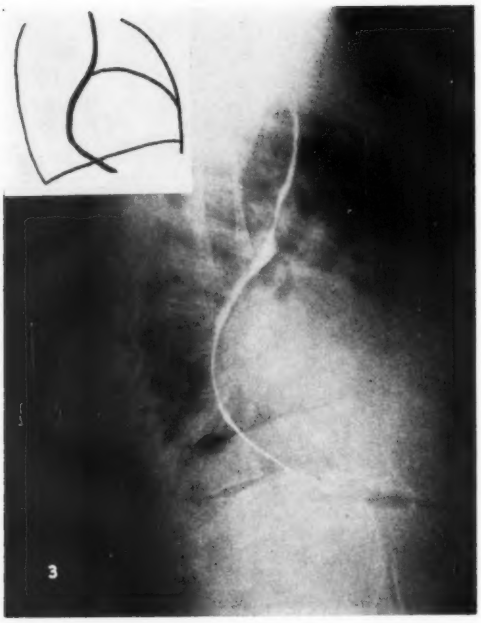
Figs. 1 and 2. Case I. Fig. 1 is a postero-anterior erect chest roentgenogram (retouched) showing the esophagus displaced to the right, cardiac enlargement, and congestive heart failure.
Fig. 2 is an anteroposterior supine overpenetrated film showing the retrocardiac esophagus lying to the left of the spine. The lateral displacement is limited by the calcified descending aorta. The esophagus starts to cross the aorta at D-11.

The patient responded to treatment and was discharged in February 1957.

In Case I, an erroneous diagnosis of left atrial enlargement was made because of the typical x-ray appearance of esophageal displacement in the frontal projection. A similar error was avoided in Case II because of awareness of the mobility of the distal esophagus. This knowledge stimulated further diagnostic studies which, along with the clinical findings, ruled out mitral valvular disease. In these 2 patients, the esophagus wandered to either side of the midline so as to rest in the costovertebral hollow in the supine position. Left lateral deviation of the esophagus was limited by the descending aorta.

One of the earliest, if not the first report concerning esophageal mobility was that of Rösler and Weiss (1), who described 7 cases of rheumatic heart disease with left atrial enlargement. In this group, the esophagus was displaced posteriorly and to the left by an enlarged left atrium. An attempt was made, by positioning 6 of the patients, to produce a right posterior displacement of the esophagus but in only one case was this possible. In this patient, the esophagus first lay slightly to the right of the midline but subsequently, during the same examination, was seen to curve moderately to the left of the midline. The lateral curving did not start at the upper border of the large left atrium but slightly below it. Three other cases have been reported recently (2–4), and the following 2 cases illustrate such findings.

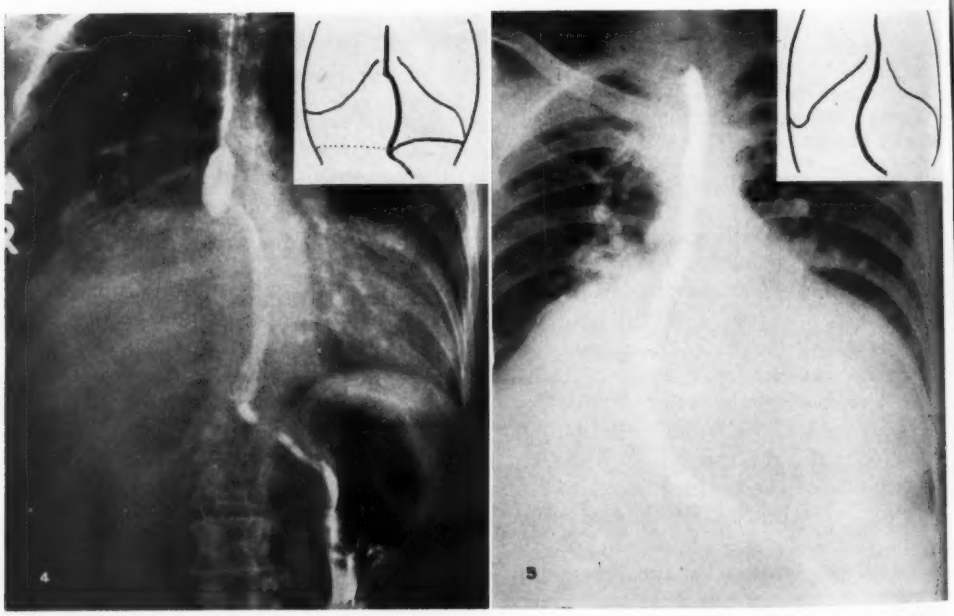
CASE III: A 53-year-old white female with a long history of rheumatic heart disease with involvement of the mitral valve was admitted to the hospital in 1949 with heart failure. X-ray examination showed the barium-filled esophagus displaced posteriorly and to the right by an enlarged left atrium (Fig. 3). In 1954, the patient was again admitted because of congestive failure, and at this time, following a barium swallow, the esophagus was seen to be displaced to the left and posteriorly by an enlarged left



atrium (Fig. 4). There had been a significant increase in the size of the heart during the previous five years. One year later, the patient was again seen in heart failure, and at this time the esophagus was displaced posteriorly and to the right (Fig. 5). These observations were incidental, and no special maneuvers to dislodge the esophagus were undertaken.

CASE IV: A 44-year-old white woman was admitted to the hospital for the first time in December 1956 complaining of substernal tightness and palpitations. There was no previous history of cardiac disease or cardiac symptoms. Physical examination and electrocardiograms were consistent with a diagnosis of mitral valvular disease, and the x-ray examination revealed left atrial enlargement with the barium-filled esophagus displaced posteriorly in the upright position. When the patient was supine, however, the esophagus could be made, by appropriate maneuvers, to wander to either side of the midline. The left lateral deviation was limited by the descending aorta (Figs. 6 and 7).

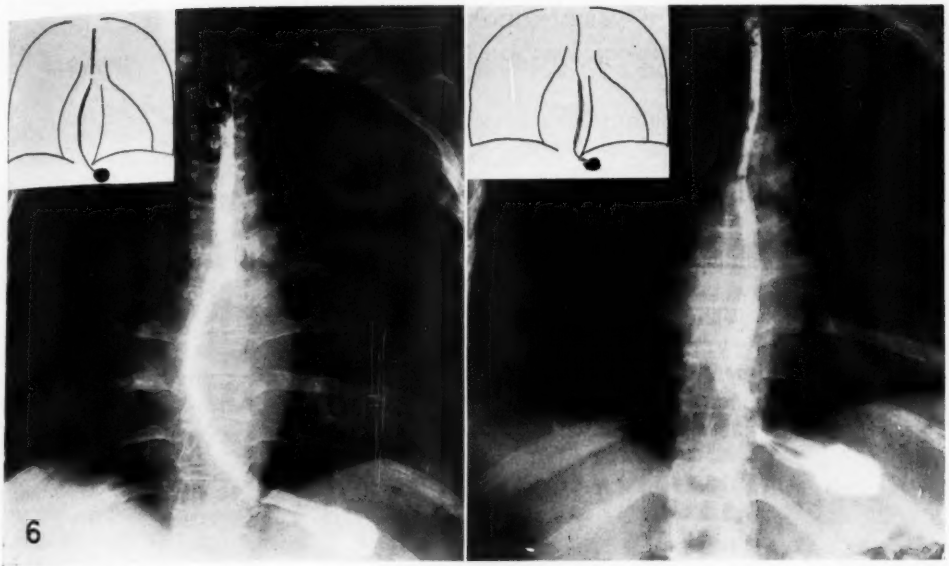
In June 1958, the patient was re-examined, and direct posterior displacement of the esophagus by the enlarged left auricle was again noted, in the up-



Figs. 3–5. Case III. Fig. 3 is a right lateral erect chest film, obtained in December 1949, showing typical posterior displacement of the esophagus by an enlarged left atrium. In the frontal projection, the esophagus is displaced to the right, as in Fig. 5.

Fig. 4 is a postero-anterior erect film, June 1954, showing left lateral deviation of the esophagus apparently limited by the descending aorta. The esophagus crosses the aorta at D-12.

Fig. 5, also a postero-anterior erect film, made in October 1955, shows displacement of the esophagus to the right by an enlarged left atrium (retouched).



Figs. 6 and 7. Case IV. Fig. 6, with the patient supine, shows the esophagus displaced to the right by an enlarged left auricle.

Fig. 7, also in the supine position, shows the esophagus lying to the left of the midline, with the lateral deviation limited by the descending aorta.

right position. With the patient upright and bending from side to side, no change in position of the barium-filled esophagus was demonstrable. In the supine position, however, the mobility previously noted was again demonstrable. The heart had not changed in size, and the degree of esophageal mobility was essentially the same.

Unusual esophageal mobility has also been described in conditions other than left atrial enlargement. Segers and Brombart (2) reported 2 cases in which the barium-filled distal esophagus was noted to wander to either side of an ectatic aorta. This finding was associated with dysphagia. Hutton (5) also observed esophageal wandering in an infant with an enlarged left auricle, associated with congenital heart disease.

CONCLUSION

The distal esophagus is occasionally very mobile and able to wander to either side of the midline, particularly when the patient is supine. When this occurs, the usual diagnostic criteria pertaining to adjacent structures, particularly the left atrium, must be applied critically and correlated with the clinical data. Otherwise, erroneous radiological diagnoses may be made.

NOTE: Grateful acknowledgment is made to Dr. Robert Shapiro, Chairman of the Department of Radiology, The Hospital of St. Raphael, for his encouragement and valuable advice, and to Miss Mary Flynn for making the photographic prints.

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(Pro le summario in interlingua, vider le pagina sequente)

SUMMARIO IN INTERLINGUA

Migration del Esophago Rectocardiac: Un Trappa in le Diagnose de Allargamento Sinistro-Atrial

Le utilitate del visualisation contrastante del esophago in le evalutation del structuras mediastinal posterior e del cameras cardiac es si ben recognoscite que certe displaciamentos esophagee ha essite investite de signification diagnostic. Tamen, le configuration roentgenoscopic del esophago es possibilemente deceptive in un micre gruppo de patientes in qui le esophago es possibilemente deceptive in un micre gruppo de patientes in qui le esophago retrocardiac es inusualmente mobile e capace de migrar al un e al altere latere del linea central, particularmente quando le patiente se trova in decubito ventral. In tal casos, le configuration roentgenoscopic post le inglutition de un buccata de barium es capace de simular allargamento sinistro-atrial, resultante in un diagnose incorrecte. Es presentate duo casos pro illustrar iste puncto. Tres altere casos es presentate in le quales mobilitate inusual del esophago esseva associate con allargamento del atrio sinistre.

Improved Visualization of the Ventricular System with the Technic of Autotomography

MANNIE MENACHEM SCHECHTER, M.B., B.Ch. (Wits), D.M.R.D. (London) and
BAO-SHAN JING, M.D., F.C.C.P.

AUTOTOMOGRAPHY was first described by Vallebona (1) in 1930. The film and tube were kept rigid and the head was rotated. In this way, detail was obtained of the bones at the base of the skull. Ziedses des Plantes (2) in 1949 ingeniously applied the technic to pneumography. Little use has been made, however, of this rewarding method. Few neuroradiological centers are aware of the detail and definition to be obtained from the procedure, which often produces information formerly available only through positive contrast ventriculography. Adequate visualization of the anterior part of the third ventricle, posterior portion of the third ventricle, aqueduct, and fourth ventricle is achieved. The use of positive contrast ventriculography may thus be reduced to a minimum. Craniotomy, with the passage of a needle through brain tissue, and shaving of the head, so distasteful to many patients, are avoided. The theory of autotomography has been described by Ziedses des Plantes.

Since the axis of rotation of the head passes through the fourth ventricle, aqueduct, and third ventricle (Figs. 1 and 2), shadows cast by these structures close to the axis of rotation will move far less than structures at a little distance from the midline, such as air over the cerebral cortex, the petrous bones, or the mastoid air cells. The maximum degree of definition appears to result from rotating the head through 10 degrees, that is, 5 degrees to each side of the midline (Figs. 1 and 2). Equally satisfactory results may be obtained by rotating the head from the midline to one side and back to the midline. A few extra degrees of rotation are sometimes necessary, as is seen in Figure 7. With 10 degrees of rotation, the fourth ventricle was still obscured by the dense petrous bone (Fig. 7, A). With an added 5 degrees, that is, 15 degrees in all (Fig. 7, B), the dense shadow of the petrous bone was obscured and the fourth ventricle outlined. The rate at which the head rotates does not appear to affect the result appreciably, so long as the movement is smooth and even.

Advantages of this technic over other methods of autotomography of this region are as follows: (*a*) No specialized equipment is required. (*b*) Only about one minute is needed for the procedure and approximately two minutes are added to the total examination time. (*c*) The technic can be incorporated into routine encephalography. (*d*) The patient need not be transported to another room or to other equipment, with resultant loss of the air from the area of the examination. (*e*) The procedure can be carried out at any stage of encephalography. (*f*) Performance is not dependent upon voluntary movement of patients, many of whom are unable to co-operate, either because of general anesthesia or failure to understand the procedure. (*g*) The method may be employed after ventriculography for routine brow-up and brow-down projections. (*h*) It is done in the sitting position normally used for encephalography.

Autotomography is not intended to supplant the positive contrast technic. Under certain circumstances the ventricular system may be distorted to such a degree that the minute quantities of air accommodated will be insufficient to cast a diagnostic shadow. Under these circumstances it will be necessary to resort to positive contrast.

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[1] From the Section of Neuroradiology, Department of Radiology, St. Vincent's Hospital, New York, N. Y.
Received for publication in June 1959.

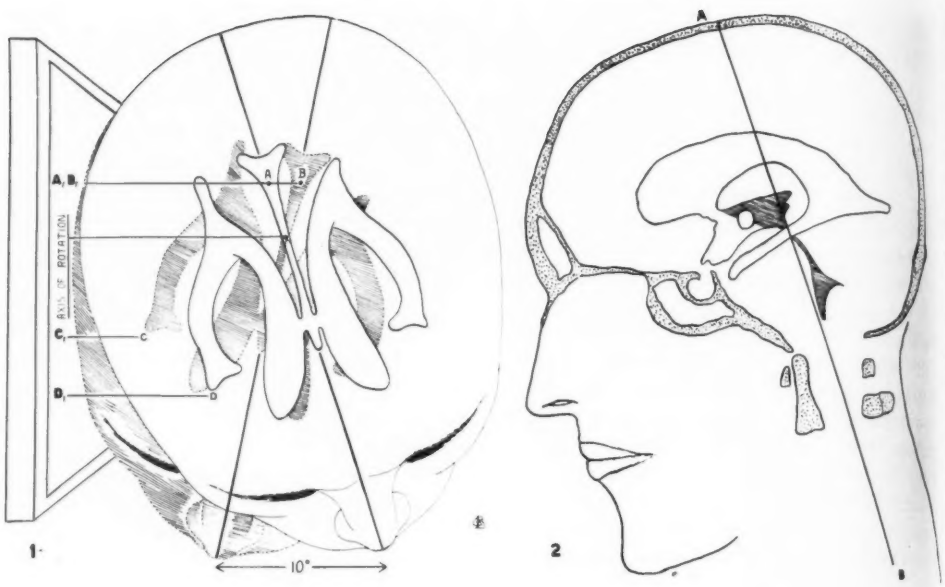

Fig. 1. Demonstration, during rotation of 10 degrees, of the axis of rotation through the posterior part of the third ventricle, aqueduct, and fourth ventricle. Note that points A and B (near the midline) are projected to A_1B_1 while points C and D (more peripheral) are projected to C_1 and D_1. There is relatively less movement of midline structures.

Fig. 2. With patient in sitting position (see also Figs. 4 and 5), AB shows the axis of rotation; the shaded area represents air in the fourth ventricle, aqueduct, and posterior part of the third ventricle.

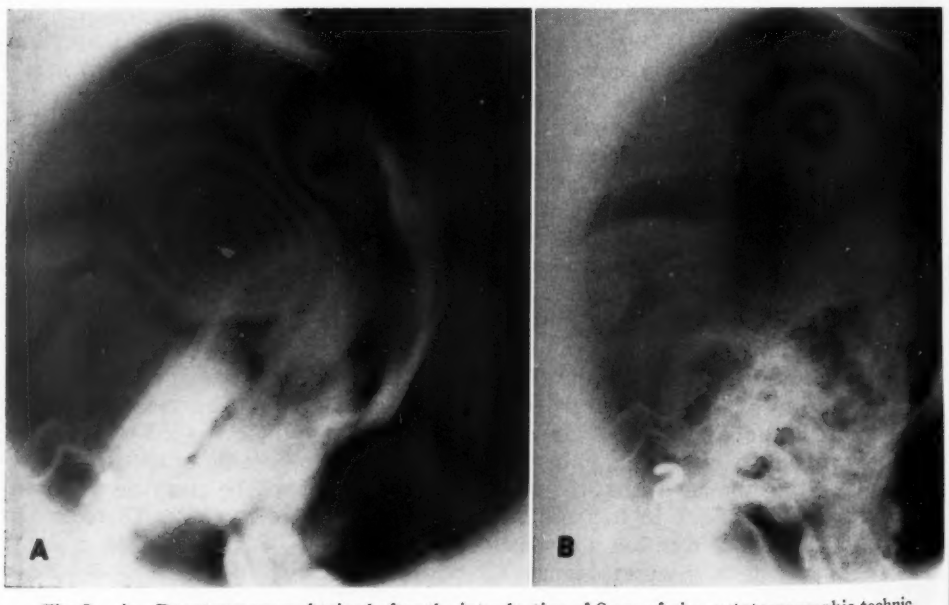

Fig. 3. A. Roentgenogram obtained after the introduction of 8 c.c. of air; autotomographic technic.
B. Film taken immediately after a further injection of 3 c.c. of air without performance of autotomography. Note the increase of definition in Fig. 3, A.

Figs. 4 and 5. Fig. 4 (left) shows position of patient during the introduction of air. Fig. 5 (right) demonstrates head harness for unconscious or unco-operative patients. Note gloved hand for manipulation of reins.

To quote Bull (3): "There is no doubt that air or oxygen is the contrast of choice. The degree of success one obtains with air is an index of one's ability as a neuroradiologist. In my view the more often one falls back on positive contrast material the less capable one proves oneself as a neuroradiologist. At this stage it must be made quite clear that unabsorbable positive contrast substances, however benign, are not desirable in the brain and I do not wish to propagate their indiscriminate use. If we find a benign substance which can be absorbed, the situation may become different. Meanwhile we are confronted with a minority of cases in which a diagnosis cannot be made with air." In this minority of cases autotomography has its greatest value. It was used by us at the National Hospital, Queen Square, London, three years ago, and Dr. Bull (4) agreed that the information obtained often obviated the use of positive contrast ventriculography. We have been employing the technic at St. Vincent's Hospital, New York, for about a year, with similar results.

The Lysholm-Schönander skull apparatus is the unit of choice and facilitates the examination. Other head units, however, will give adequate results. The technic will be described as applied to encephalography and ventriculography.

1. During encephalography (*a*) for demonstration of the fourth ventricle, aqueduct, and posterior end of the third ventricle; (*b*) for the demonstration of the anterior part of the third ventricle and basal cisterns: The patient is placed in a comfortable sitting position with the neck flexed and the chin drawn in toward the chest (Fig. 4). During the introduction of air he is instructed to rotate the head slowly from side to side as if saying "no." Immediately after or during the introduction of 5 to 8 c.c. of air, he starts rotating the head and the radiographic exposure is begun. Rotation of the head is continued until the completion of the exposure. If the patient is unco-operative or unconscious, then rotation can be accomplished with the use of a head harness manipulated by an assistant (Fig. 5). A routine lateral film taken just before or just after autotomography for comparison demonstrates

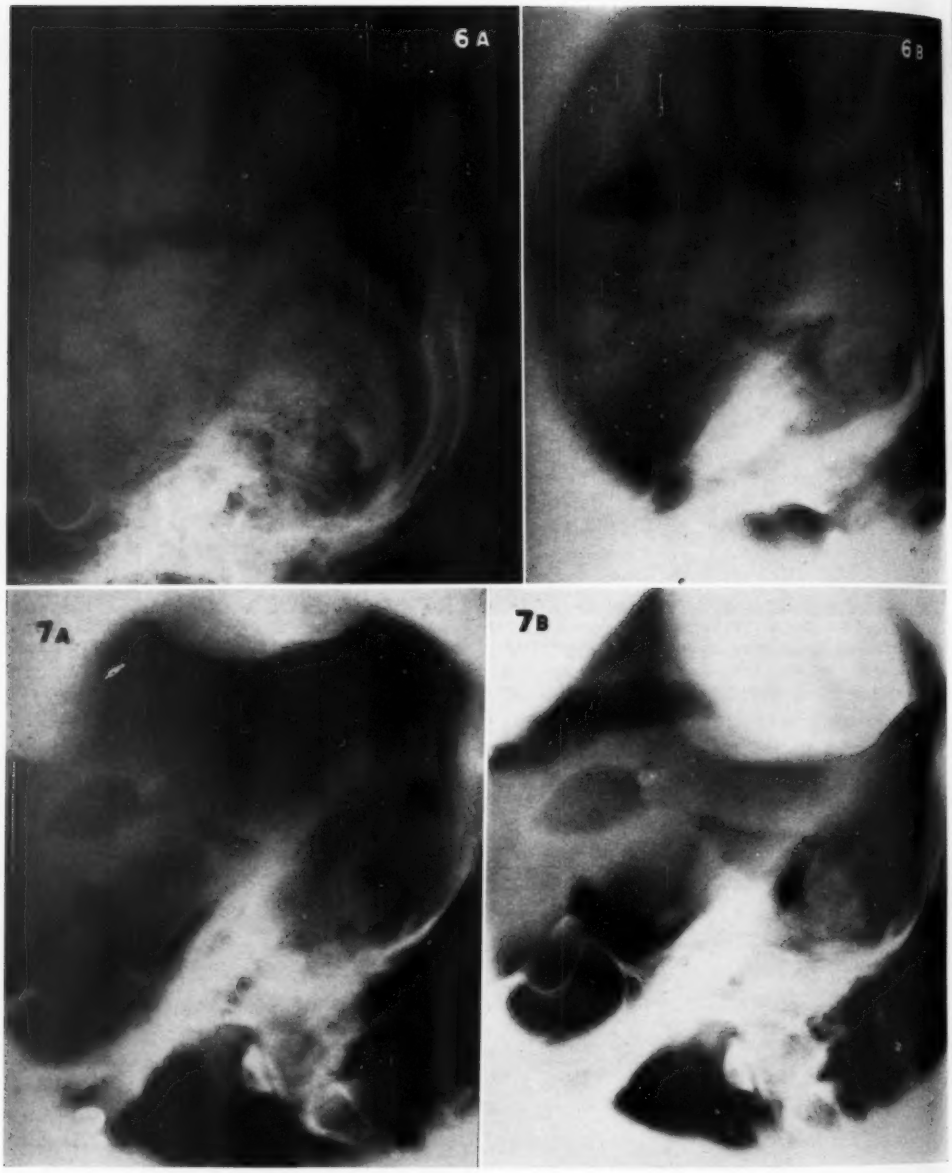

Fig. 6. A. Film obtained after injection of 8 c c. of air. Note poor definition of the fourth ventricle, aqueduct, and posterior end of third ventricle.

B. Roentgenogram made after a further injection of 3 c.c. of air and with the employment of autotomography. Note the increase in definition.

Fig. 7. A. Roentgenogram obtained after introduction of 8 c.c. of air: autotomography. With a 10-degree rotation of the head, the fourth ventricle is obscured by the superimposed petrous bones.

B. Film taken with a head rotation of 15 degrees. The superimposed shadow of the petrous bone is now obscured and the confines of the fourth ventricle are well outlined.

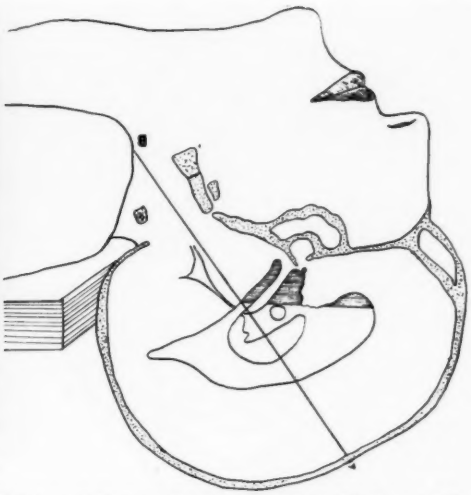

Fig. 8 (left). Brow-up, hanging-head position for visualization of the anterior portion of the third ventricle. The gloved hand rotates the head.

Fig. 9 (right). Diagram of brow-up, hanging-head position. The shaded area represents the trapped air in the frontal horn, anterior part of the third ventricle, and the temporal horn. The axis of rotation is still AB.

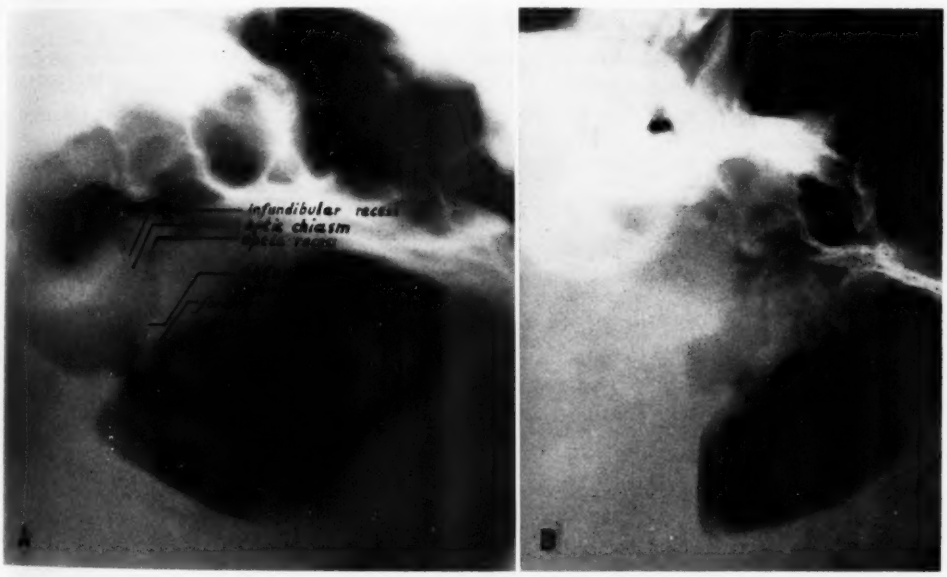

Fig. 10. A. Film obtained with autotomography, demonstrating the added contrast and definition. Note the optic and infundibular recesses, the optic chiasm, the foramen of Munro, and the anterior commissure.

B. Brow-up, hanging-head-position, showing the dilated lateral ventricles and the anterior end of the third ventricle.

the added definition obtained by this method (Figs. 3, 6, and 7). To obtain definition of the anterior part of the third ventricle by autotomography, approximately 25 c.c. of air is introduced into the ventricular system either by encephalography or ventriculography. The technic of filling of the third and fourth ventricles varies with the site of introduction of the air, that is, the lumbar subarachnoid space or the lateral ventricles through a ventricular puncture.

Fig. 11. Hanging-head autotomogram of the anterior part of the third ventricle and the lateral ventricles. The displacement backward of the anterior wall of the third ventricle was caused by a meningioma of the tuberculum sellae.

The patient is then placed supine (Figs. 8 and 9) and air is introduced into the third ventricle by the "hanging head" method or, if this is unsuccessful, by the "somersault" technic. This maneuver simply introduces air into the third ventricle. With the air now in the anterior part of the third ventricle autotomography may again be used to demonstrate this region to better advantage.

Fig. 12. Brow-down position after ventriculography for visualization of the posterior part of the third ventricle, fourth ventricle, and aqueduct. The gloved hand rolls the head from side to side.

The improved definition of the anterior commissure, chiasmatic and infundibular recesses, optic chiasm, and the foramen of Munro is seen in Figure 10, A.

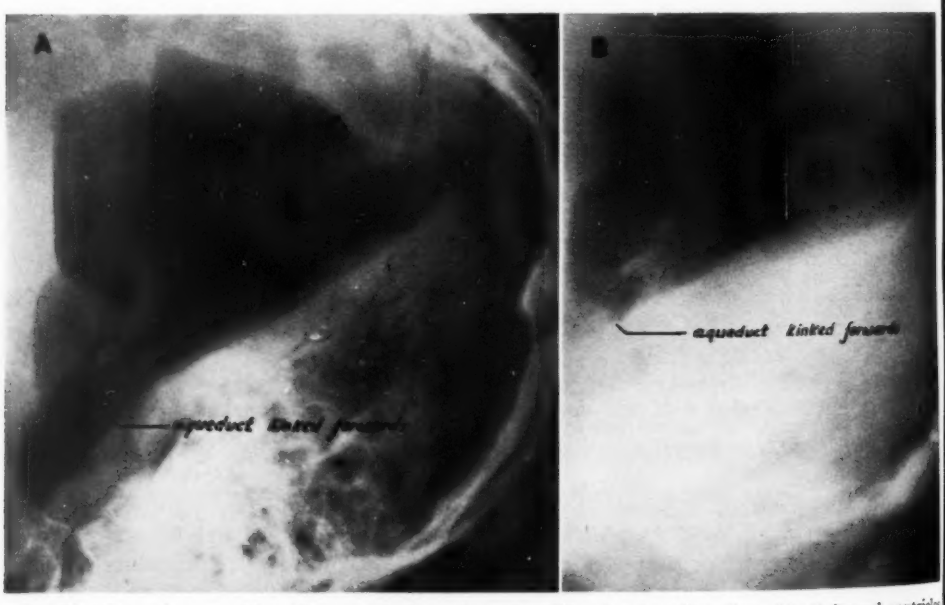

Fig. 13. Brow-down position after ventriculography. A. Film showing dilatation of both lateral ventricles and posterior end of third ventricle. The aqueduct is kinked forward.
B. With autotomography the forward kink of the aqueduct is demonstrated to much better advantage.

Fig. 14. A. Routine lateral film was not diagnostic, as the shadow of the fourth ventricle was obscured by mastoid air cells.
B. Displaced fourth ventricle is shown to better advantage with autotomography. The circled dot represents the normal position of the fourth ventricle.

2. During ventriculography: For autotomography of the posterior part of the third ventricle after ventriculography, the patient is placed in the brow-down position as shown in Figure 12, and the head can be rotated by rolling it from side to side as shown. The patient can be instructed to do this, or it can be done by the gloved hand of an assistant, as shown in Figure 12. Figure 13 shows the films obtained in this position. Note especially the kinked aqueduct seen more clearly in Figure 13, B, an autotomogram. A stationary grid with a ratio of 12:1 is used and a small cone gives added definition. The fine focus of the x-ray tube is preferred, a 1-mm. focus being adequate; 66 kv and 50 ma are used, with an exposure time of four seconds. The technic varies according to the part of the ventricular system being investigated.

SUMMARY

The technic of autotomography for better visualization of the third ventricle, aqueduct, and fourth ventricle during pneumography has been described, and the advantages over other forms of tomography have been discussed. This simple maneuver gives vital information which is often sufficient for diagnosis, thus obviating the use of positive contrast ventriculography.

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SUMMARIO IN INTERLINGUA

Meliorate Visualisation del Systema Ventricular per Medio del Technica del Autotomographia

Es describite le technica del autotomographia visante a un meliorate visualisation del tertie ventriculo, del aqueducto, e del quarte ventriculo in studios pneumographic. Le technica autotomographic non es presentate como un reimplaciamento del methodo a contrasto positive, proque in certe circumstantias le systema ventricular exhibi un si pronunciate distorsion que le micrissime quantitates de aere que pote esser utilisate es insufficiente pro effectuar un umbra diagnostic in le pellicula.

Iste simple manovra provide information vital que suffice frequentemente pro le diagnose, rendente alora innecessari le uso de ventriculographia a contrasto positive.

Frontal Avascularity: An Angiographic Observation in Frontal Lobe Tumors[1]

EMANUEL H. FEIRING, M.D., JEROME H. SHAPIRO, M.D, and AVNER I. FELDMAN, M.D.

THE DIAGNOSIS of an expanding intracranial lesion by means of angiography is dependent on the disposition of the cerebral blood vessels and/or the demonstration of an abnormal vascular pattern. In cases in which the presence of a tumor is indicated by the displacement of cerebral arteries, a zone of avascularity, usually in the arterial phase, may also be evident. This commonly leads to speculation as to the type of tumor present. In this paper, however, we are not concerned with avascularity as an indication of the possible nature of the underlying lesion but wish, instead, to call attention to a phenomenon that may be observed in the presence of space-occupying lesions within the anterior cranial cavity. We have noted that not infrequently in cases of frontal lobe tumor there is a paucity of visible blood vessels in the frontal region in the postarterial phase of the arteriographic study. This phenomenon has been especially apparent with the use of an automatic rapid film-changer which provides more detailed angiographic data.

A total of 41 frontal lobe tumors were found suitable for study of the vascular pattern in the postarterial phase. In 14 cases no abnormality was discernible (Table I). In 27 the angiograms were characterized by an absence or diminution of

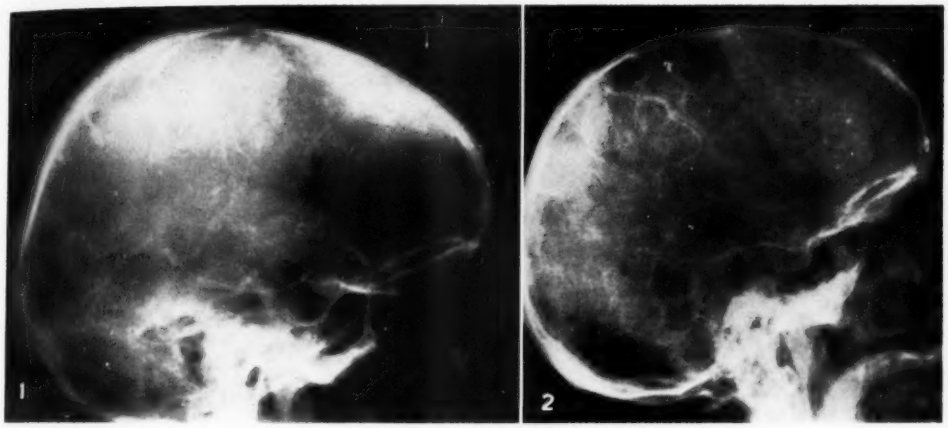

Fig. 1. Frontal glioblastoma multiforme: Frontal avascularity in the venous phase.
Fig. 2. Glioblastoma of the frontal lobe: Venous avascularity of the frontal region.

TABLE I: NORMAL POST-ARTERIAL PATTERN (14 CASES)

1.	Metastatic carcinoma	6
2.	Meningioma	2
3.	Aneurysm	1
4.	Hematoma	1
5.	Astrocytoma	2
6.	Glioblastoma multiforme	1
7.	Mixed tumor (sarcoma and astrocytoma)	1

TABLE II: POST-ARTERIAL AVASCULARITY (27 CASES)

1.	Meningioma	8
2.	Glioblastoma multiforme	6
3.	Metastatic carcinoma	4
4.	Hematoma	3
5.	Hemangioblastoma	1
6.	Metastatic melanoma	1
7.	Oligodendroglioma	1
8.	Oligodendroblastoma	1
9.	Mixed glioma	1
10.	Malignant tumor, type unknown	1

[1] From the Divisions of Neurosurgery and Diagnostic Radiology, Montefiore Hospital, and Department of Radiology, New York University College of Medicine, New York, N. Y. Accepted for publication in June 1959.

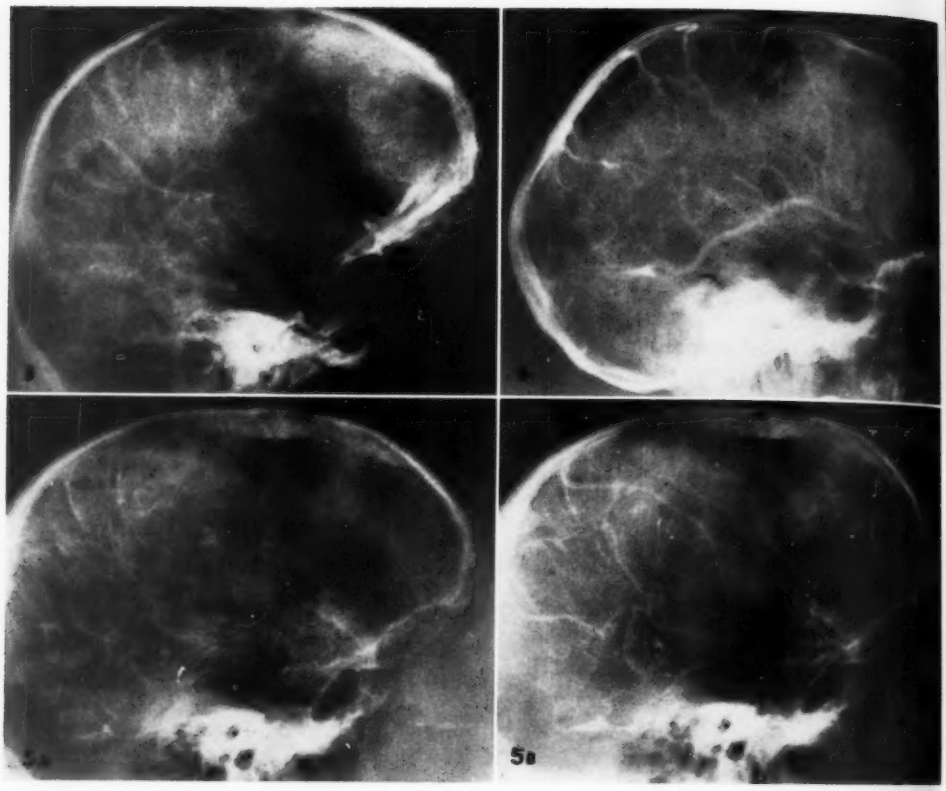

Fig. 3. Frontal meningioma: Avascularity in the frontal area during the early venous phase.
Fig. 4. Frontal parasagittal meningioma: Venogram showing frontal avascularity.
Fig. 5. Frontal parasagittal meningioma: Avascularity in the early venous phase (A) and relative avascularity in venous phase (B).

opacified blood vessels in the frontal region in the venous or "intermediate" phases (Table II; Figs. 1–8).

DISCUSSION

It is the network of vessels leading into the superficial veins of the brain, specifically those draining the frontal region, that appear to be less well visualized in frontal lobe tumors. According to Bailey (1), the superior cerebral veins normally vary in number from six to twelve, those located anteriorly being relatively smaller. In analyzing our case material, we have taken into account this variation in number and size of the superficial frontal veins.

Since the effects produced by a tumor on the cerebral circulation are not fully understood, the explanation of the phenomenon of avascularity is not altogether clear. It is conceivable that a pressure gradient exists which renders the small veins in the anterior cranial cavity more susceptible to the effects of local compression. In view of the fact that the frontal lobes are relatively "silent" areas, it is also possible that expanding lesions in this region are not suspected clinically and hence not studied by angiography until their size is such that their very bulk is responsible for a zone of apparent avascularity (Fig. 8).

Very little has been written concerning the appearance of the superficial veins in cases of intracranial mass lesions. Poor visualization, as well as displacement of the veins, was described by Gvozdanović

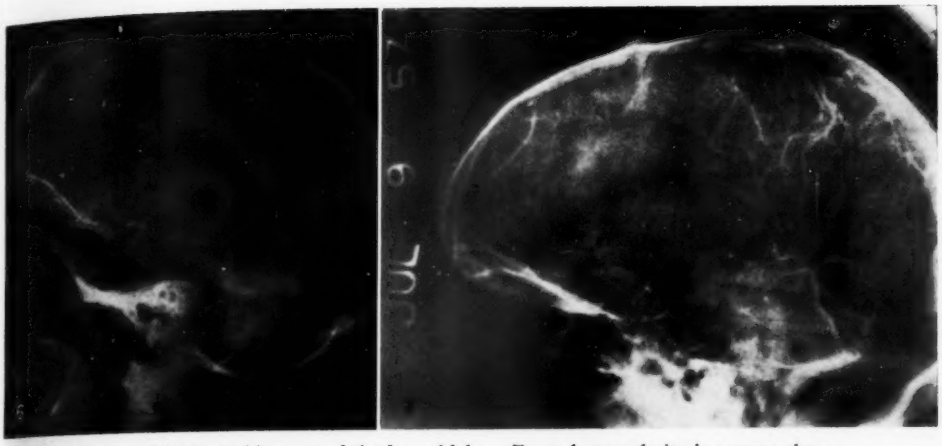

Fig. 6. Oligodendroblastoma of the frontal lobe: Frontal avascularity in venous phase.
Fig. 7. Frontal lobe hematoma: Relative frontal avascularity in phlebogram.

Fig. 8. Frontal meningioma. A. Tumor, outlined by stain, and displaced peripheral vessels in arterial phase B and C. Frontal avascularity in the venous phases.

(2) in several instances of neoplastic disease. The venograms of two frontal lesions, a tuberculoma and an astrocytoma, illustrating a paucity of frontal veins are included in his report. Frontal avascularity in the venous phase of a study of an epidural hematoma located in the frontal region is demonstrated in a paper by Léger, Bertrand and Dufresne (3). According to Lorenz (4), ascending superficial veins of the area involved are frequently not visualized in cases of frontal, parietal, or occipital tumors.

It is realized that this observation is of limited value as an aid in localization. The criteria for the diagnosis of a frontal lobe tumor are well established on the basis of the arterial pattern, especially the marked curvilinear displacement of the anterior cerebral artery across the midline in the anteroposterior projection. However, in those cases in which, for anatomic reasons, the anterior cerebral artery is not visualized on the side of the injection of contrast medium, frontal avascularity in the postarterial phase may be useful.

SUMMARY

Frontal avascularity may be observed in the postarterial phase of cerebral angiography in the presence of frontal lobe tumor. This phenomenon may be of value in localizing the site of the lesion.

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SUMMARIO IN INTERLINGUA

Avascularitate Frontal: Un Observation Angiographic in Tumores de Lobo Frontal

Avascularitate frontal es incontrate in le phase post-arterial de angiographia cerebral in le presentia de tumor de lobo frontal. Iste constatation pote esser de valor in casos in que, pro rationes anatomic, le arteria antero-cerebral non es visualisate al latere del injection del substantia de contrasto.

Larger Volume Pantopaque Lumbar Myelography[1]

HAROLD HAFT, M.D., CHARLES E. WEINSTEIN, M.D., and ERICH G. KRUEGER, M.D.

DESPITE REPORTS encouraging the employment of larger amounts of Pantopaque in myelography (1, 2, 4), there appears to be a general reluctance to use any more than 6 c.c. in examining the lumbar canal. This hesitancy seems to be based on the premise that the more of the medium used, the higher the complication rate, since more supposedly will be left in the subarachnoid space. It has been our general impression that this presumption is false and that there are decided advantages in the use of larger volumes of contrast material in myelography, namely, better films, diagnostically and technically; less overall time and effort on the part of the surgeon and the radiologist; less radiation and discomfort to the patient.

In order to test this general impression, 30 patients were studied. Those with a clinical diagnosis of radiculitis involving the L4, L5, and S1 roots only were used. Patients having had previous myelograms and/or spine operations were not included in the study. The 30 patients were divided into three equal groups, receiving 6, 9, and 12 c.c. of Pantopaque. Attempts were made to place the needle in the L2-3 or L3-4 interspace in all cases. The studies were carried out by the resident staff, largely by junior residents.

Records were obtained of the time taken from the first film to the initiation of Pantopaque removal; the time required for the removal of all possible Pantopaque (where necessary, additional spinal needles were used for this purpose); the amount of Pantopaque remaining. An attempt was made, also, to measure radiation exposure to the patient, but this had to be discontinued for external reasons.

Initially, 14 × 17-inch films in the anteroposterior, lateral, and both 45° oblique projections were obtained with the patient standing. The diagnosis was invariably made on these films. However, the rest of the lumbar canal was also studied, under fluoroscopic control.

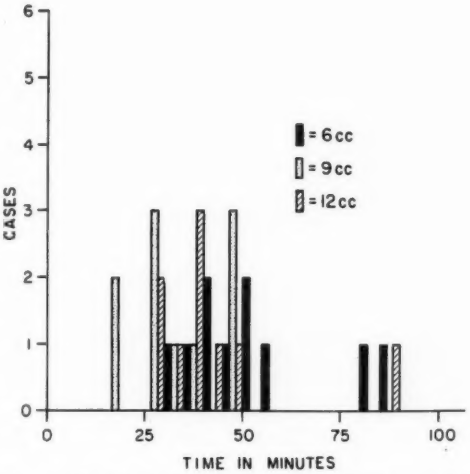

Fig. 1. Time from first film to completion of diagnostic phase. Average, 45.8 minutes.

RESULTS

The average time from the first film to the completion of the diagnostic phase was 56 minutes for 6 c.c., 35 minutes for 9 c.c., and 46 minutes for 12 c.c. (Fig. 1). The average time for all patients was 45.8 minutes. In 3 patients the time taken was greater than that expected by chance; 2 of these had received 6 c.c. and the other 12 c.c. (mean (m) = 45.8′; standard deviation (σ) = 19.2′).

The average time for the removal of all possible contrast material was 20.5 minutes for 6 c.c., 13 minutes for 9 c.c., and 10.5 minutes for 12 c.c. (Fig. 2). The average time for all patients was 14.8 minutes. Only 1 patient receiving 6 c.c. fell into the zone beyond chance (m = 14.8′; σ = 11.9′).

[1] From the Neurosurgical Section and Radiology Service, Veterans Administration Hospital, Bronx, N. Y. Accepted for publication in June 1959.

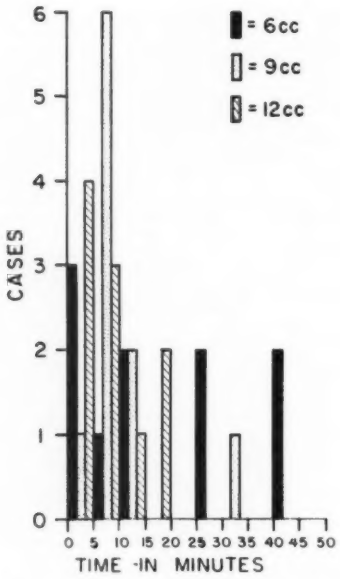

Fig. 2. Time for removal of contrast medium. Average, 14.8 minutes.

The total time from the first film to the removal of the needle after as complete evacuation of the medium as possible was 76.5 minutes for 6 c.c., 48.5 minutes for 9 c.c., and 56.5 minutes for 12 c.c. (Fig. 3). The total average time for all patients was 58 minutes. In 2 patients, both in the 6-c.c. category, the time extended beyond the zone of chance variation (m = 58′; σ = 25.9′).

The amount of Pantopaque remaining in the canal on completion of the myelogram was 1.7 c.c. for an injection of 6 c.c., 0.7 c.c. for 9 c.c. and 0.7 c.c. for 12 c.c. (Fig. 4). The average amount remaining for all patients was 1.1 c.c. Four patients retained more than was expected by chance; 3 were in the 6 c.c. category and the other in the 12 c.c. group (m = 1.1 c.c.; σ = 1.6 c.c.).

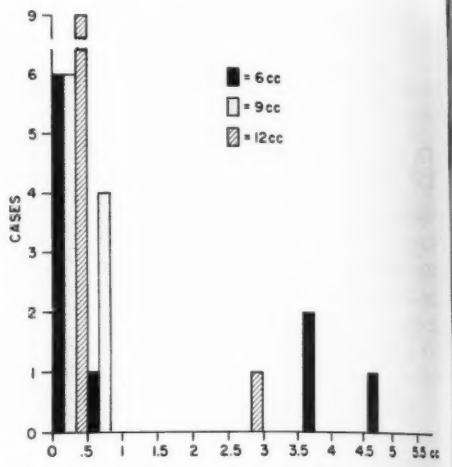

Fig. 4. Amount of medium remaining in the spinal canal. Average, 1.1 c.c.

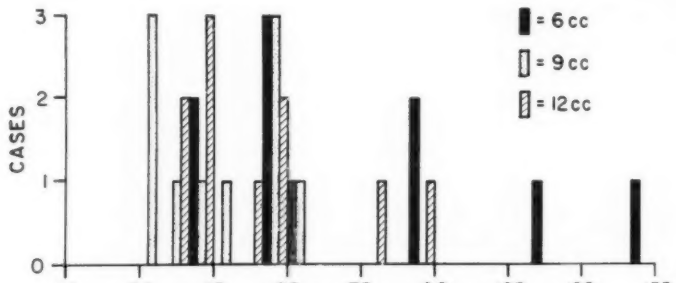

Fig. 3. Total time from first film to as nearly complete evacuation of the medium as possible. Average, 58 minutes.

There was no correlation between the spinal fluid total protein and the time needed to complete the study.

On upright films, 6 c.c. of the medium was seen to reach the lower half of the body of L4; 9 c.c. reached just above the

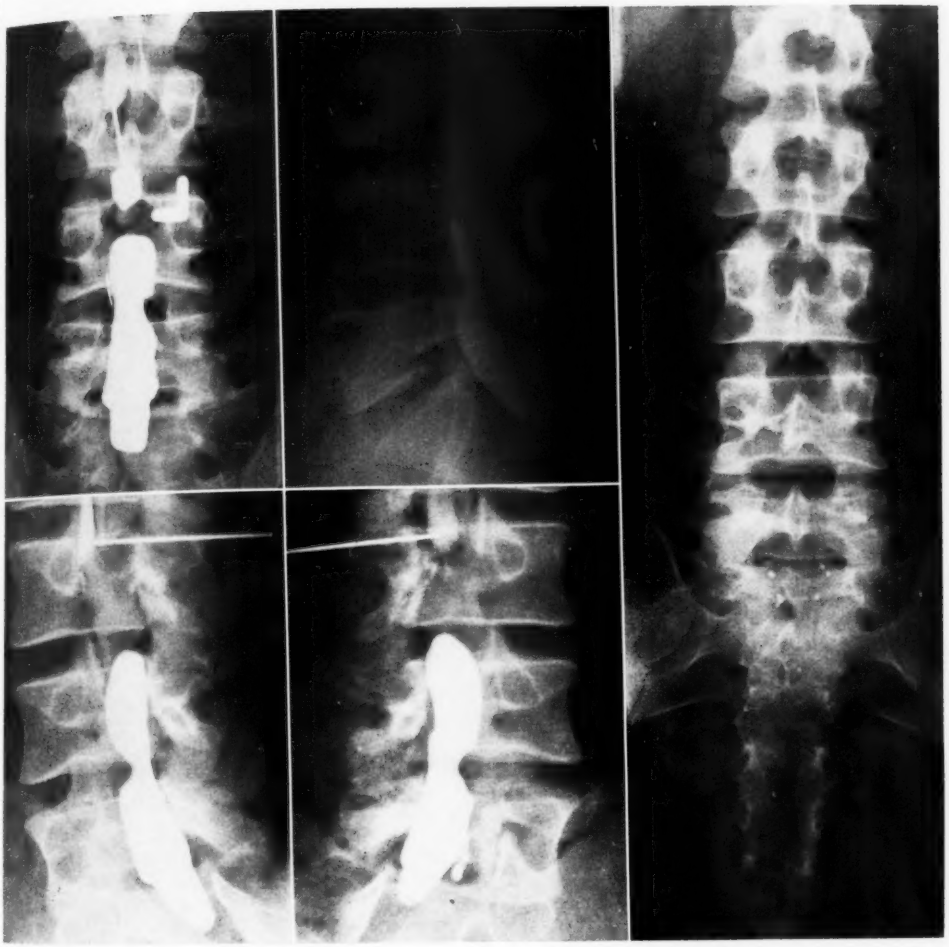

Fig. 5. Myelogram made with 6 c.c. Pantopaque. Postero-anterior, lateral, and oblique views—all upright Film at extreme right shows amount of medium remaining in spinal canal.

L3-4 interspace, and 12 c.c. reached the middle of the body of L3 (Figs. 5–7).

The films were of good quality in all cases. The myelogram disagreed with the clinical findings in 2 patients (one receiving 6 c.c., the other 9 c.c.); in these, the clinical localizations were correct. There were no post-myelographic complications.

Obviously this small series does not lend itself to a true statistical study. In addition, the method is not exactly standardized, since many residents participated in the examinations. The data demonstrate, however, that with larger volumes of contrast material lumbar myelography takes less time and less of the medium remains in the subarachnoid space. The time could be shortened even more appreciably by limiting the fluoroscopic examination of the rest of the lumbar canal to cases with strong indications for extended study and by the co-ordination of experienced radiologists and surgeons. For these reasons, larger volume myelography should be of particular value in small nonteaching hospitals. In our study 9 c.c. proved to be the optimum volume of Pantopaque; in all phases of the investigation 6 c.c. was the least satisfactory.

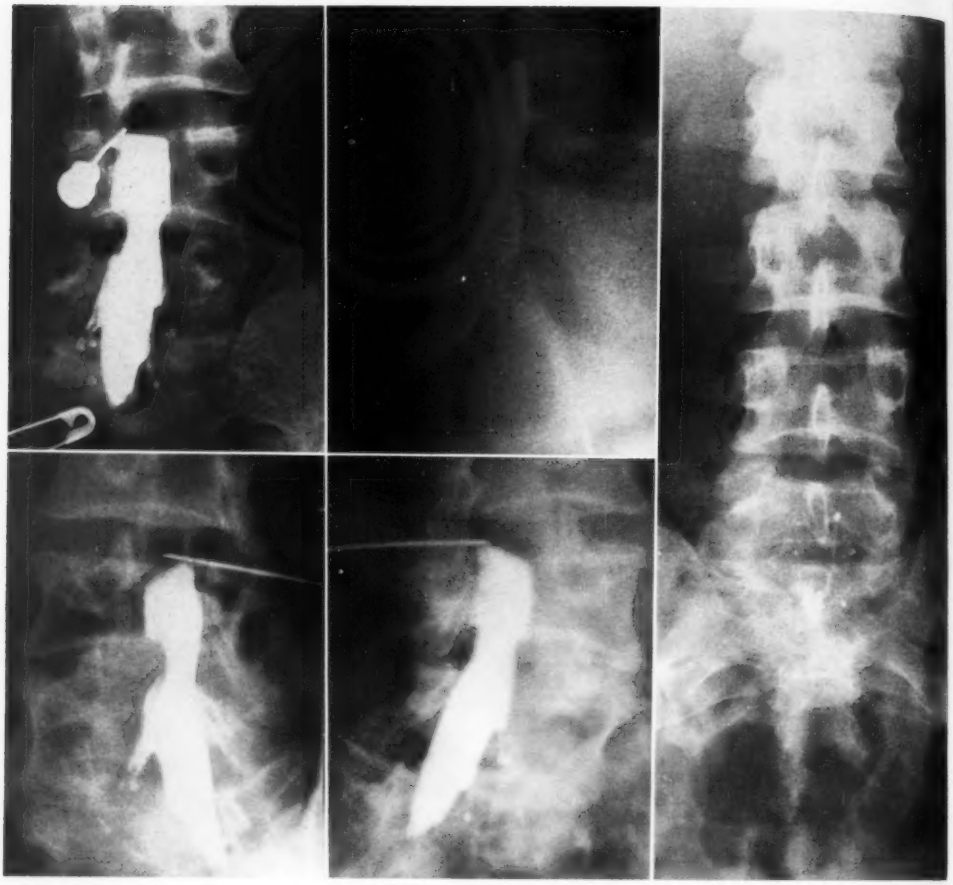

Fig. 6. Myelogram made with 9 c.c. Pantopaque. Postero-anterior, lateral, and both oblique projections—all upright. Roentgenogram at extreme right shows amount of medium remaining in spinal canal.

Bell *et al.* (1) first described an erect method of myelography using larger quantities of contrast material. They felt that not only did the erect position best demonstrate the myelographic defect, but that, irrespective of the volume of medium used, "it is the last cubic centimeter which presents the greatest difficulty and time consumption" in removal. Negrin (5) has recently described a technic using a polyethylene catheter that may solve this problem. Norman (6) found fewer reactions to 6 c.c. than to 3 c.c. and felt that the incidence of reaction was related to the volume of medium left in the canal. Malis *et al.* (4) have described a full-column technic wherein just enough oil is introduced into the lumbar canal to fill the subarachnoid space completely to the suspected level. Without complete filling of the canal, the oblique views lose much of their usefulness (3). Brierre and Colclough (2) believe that the removal of the medium is easier with larger amounts. They attribute this to decreased globulation and "to the fact that the needle more easily penetrates the medium. The depth of the mass plus its weight is thought to aid in breaking its surface tension. This same surface tension causes the entire mass to be drawn to the needle when suction is applied."

Fig. 7. Myelogram made with 12 c.c. Pantopaque. Postero-anterior, lateral, and oblique views—all upright Film at extreme right shows amount of medium left in spinal canal.

SUMMARY

The advantage of using larger volumes of Pantopaque in lumbar myelography has been demonstrated in a study of 30 patients. The larger volumes give better films, diagnostically and technically; require less time and effort on the part of the physician; and cause less discomfort to the patient, both in respect to actual study and potential post-myelographic complications because of the smaller amount remaining in the spinal canal. In addition, because of the shortening of the time required and the decreased need of fluoroscopic control, there is probably less radiation to patient and physician. The study indicates that 9 c.c. is the optimum volume for lumbar contrast myelography.

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SUMMARIO IN INTERLINGUA

Myelographia Lumbar con Plus Grande Volumines de Pantopaque

Le utilitate de plus grande volumines de Pantopaque in myelographia lumbar esseva demonstrate in un studio de 30 patientes. Le augmentate volumines produce melior pelliculas, diagnostica- e etiam technicamente. Le tempore e le effortio requirite del parte del medico es reducite, e le disconforto causate al patiente es minus grande, tanto con respecto al studio mesme e etiam con respecto al possibile complicationes post-myelographic. Le explication de isto es que minus grande quantitates del substantia persiste in le canal spinal. In plus, viste le reduction del tempore requirite e le reducite necessitate de verificationes fluoroscopic, il es probabile que le radiation recipite per le patiente e per le medico es minus grande. Le studio indica que 9 cm^3 es le volumine optimal pro lumbo-myelographia de contrasto.

Sacral Aplasia (Agenesis)[1]

MILTON J. H. GRAND, M.D., STUART EICHENFELD, M.D., and HAROLD G. JACOBSON, M.D.

CONGENITAL ABSENCE of part or all of the sacrum is of infrequent occurrence. Gross aplasia (frequently called agenesis) of the caudal portion of the spine from the mid-thoracic level or higher is probably incompatible with life at an early stage of fetal development and would therefore tend to be unreported. Absence of the terminal part of the coccyx would also be likely to remain undetected unless found during unrelated roentgen studies. An analysis of spinal roentgenograms of 700 children was made by Shands and Bundens (1) in 1956. In a group of 169 anomalies, there were 5 cases of absence of spinal segments, 3 of congenital absence of all or part of the lumbar spine, sacrum, and coccyx, and 1 of solitary coccygeal absence.

In 1852, Hohl (2) reported absence of the sacrum for the first time. The first complete review of this subject, however, was presented by Freedman (3) in 1950. By that time, 54 cases had been reported, to which Freedman added a fifty-fifth. An excellent and comprehensive review by Blumel, Evans, and Eggers, recently published (4), presents data on 50 new cases, of which 8 were personally observed and the remaining 42 were collected by correspondence with 300 orthopedic surgeons in the United States. In this series 32 cases showed complete absence of the sacrum and 18 partial absence.

Our purpose is to describe and emphasize the clinical and roentgen findings of sacral aplasia. It is important that the clinician and radiologist be made aware of the existence of this conditon and of its relationship to cord bladder, fecal urinary incontinence, infection, and abnormalities of gait. We shall present 3 new personally observed cases of sacral aplasia, of which 2 were complete and 1 partial.

ANATOMY AND MORPHOGENESIS

Gray's *Anatomy* (5) adequately describes the development of the sacrum and coccyx from nine separate segments, and the detailed discussion of the embryology of these spinal segments may best be read in the original. Briefly, after development, the large triangular bone known as the sacrum is situated in the lower part of the vertebral column at the upper and posterior portion of the pelvic cavity. The sacrum is inserted between the two hip bones as a wedge articulating superiorly with the last lumbar vertebra and at its lower margin with the coccyx.

CLINICAL MATERIAL

CASE I: A. W., a 3 1/2-year-old white boy, was admitted to Montefiore Hospital on June 12, 1957, with a history of fecal and urinary incontinence since birth. Motor activity was reported to be unimpaired, and the family had not been aware of any sensory deficits.

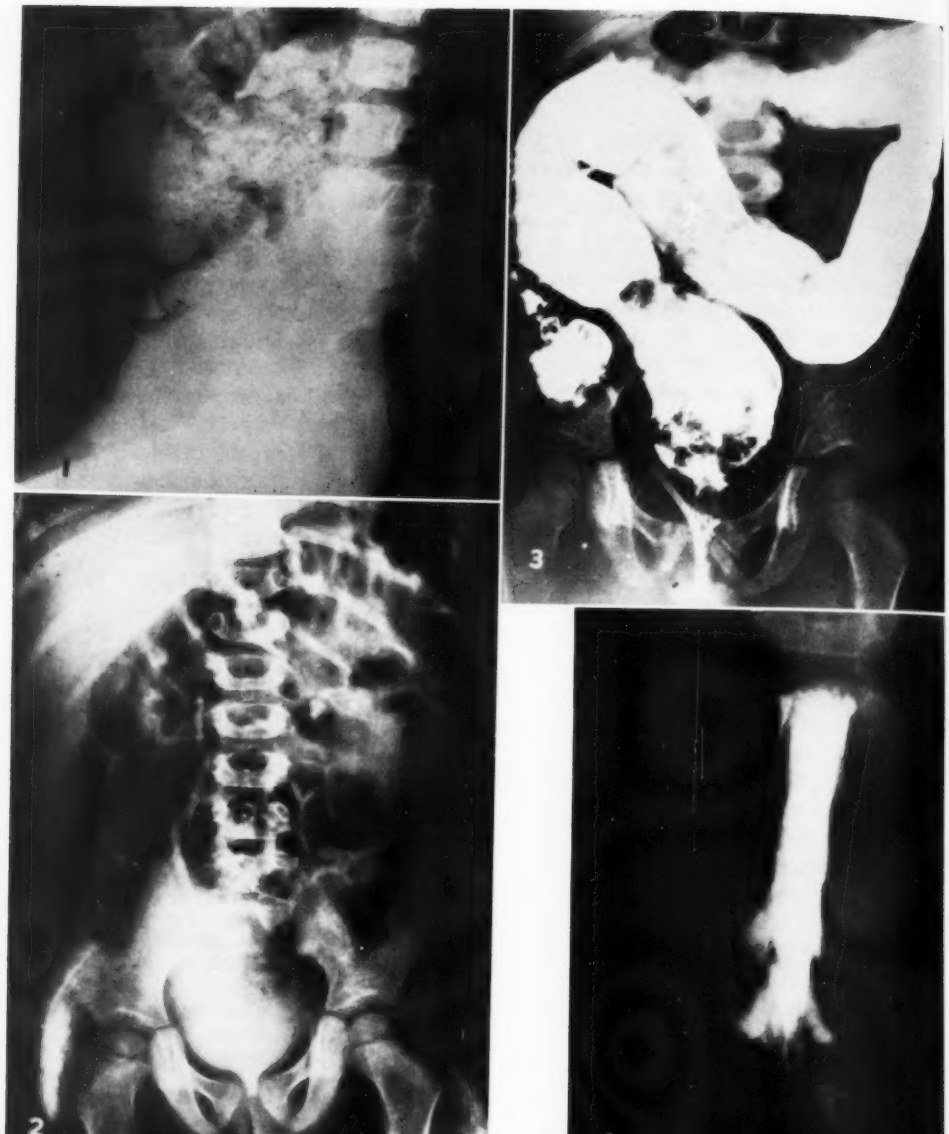
On examination, the pertinent findings included a protuberant abdomen, a soft-tissue mass over the sacral area, atrophic glutei, absence of natal creases, and thin, atrophic legs. Positive neurologic findings consisted of the inability to stand on either foot, absence of ankle jerks, and bilateral Babinski reflexes. Rectal tone was absent. Laboratory data were noncontributory. Electromyograms of the anterior tibial muscles were normal.

Roentgen examination of the spine showed no significant abnormality in the dorsal and lumbar segments. The sacrum was seen to be absent, except for the first segment (Fig. 1).

Roentgen examination of the chest and skull showed no abnormality except for bilateral cervical ribs.

Urographic examination of the renal tract by subcutaneous injection of Hypaque on June 20, 1957, showed the left upper urinary tract to be normal. There was slight but definite dilatation of the entire collecting system of the right kidney, with some irregularity of contour of the calyceal structures. The right ureter was dilated down to the point where it usually crosses the sacrum. The urinary bladder was somewhat dilated and presented a funnel-shaped outlet with a collection of opaque

[1] From the Department of Pediatrics and the Division of Diagnostic Radiology, Montefiore Hospital, and the Department of Pediatrics, The Mt. Sinai Hospital, New York, N. Y. Accepted for publication in May 1959.



Figs. 1–4. Case I.

Fig. 1. Lateral view of lower spine demonstrating aplasia of the 1st sacral segment, with absence of the rest of the sacrum.

Fig. 2. Intravenous urogram, showing appearance consistent with neurogenic bladder; collection of opaque medium in the region of the scrotum, indicating incontinence. The right upper urinary tract shows dilatation. The aplasia of the sacrum with residual 1st sacral segment is noted.

Fig. 3. Massive dilatation of the colon, demonstrated by a barium enema study; large amount of fecal content in the bowel.

Fig. 4. An abnormally high lumbocaudal sac ending at the L4-S5 disk cartilage region, seen during a myelographic examination.

medium in the region of the scrotum, reflecting the presence of incontinence. The appearance of the outlet of the urinary bladder was felt to be consistent with the usual findings seen in neurogenic bladder (Fig. 2).

A barium enema study done on June 26, 1957, showed a markedly distended colon, with retention of a massive amount of fecal material in the entire large bowel (Fig. 3). Zones of narrowing were demonstrated in the rectosigmoid region and proximal portion of the sigmoid; these areas of narrowing were distensible. Aganglionosis was not felt to be present. The narrowing was thought to be associated with spasm secondary to retained fecal material. The findings were consistent with a neurogenic colon.[2]

A myelogram obtained on July 8, 1957, aside from a high sacral sac ending at the L-4 disk cartilage, showed no abnormality (Fig. 4).

Comment: The diagnosis of sacral aplasia was obvious on the pediatric service because of the absence of gluteal masses noted while the child was in the standing position. A large fat pad was palpated over the area usually occupied by the sacrum. The clinical diagnosis of absence of the sacrum was confirmed by the roentgen examination. The slight dilatation of the urinary tract on the right side, the neurogenic bladder, and the marked fecal retention and neurogenic colon as demonstrated by the barium enema examination were all felt to be part of the syndrome.

CASE II: J. L., a white male child, was first admitted to the Mt. Sinai Hospital on Feb. 27, 1952, at the age of three years, for evaluation of his physical and mental status. Delivery had been normal following an uneventful pregnancy and there had been no obvious congenital abnormality at birth. The family history was noncontributory except that both parents were of relatively short stature. The child was referred to the hospital because he was small in stature and apparently mentally retarded. Growth and development were normal except for a delay in walking and speech. There was a history of long-term constipation, with pain on defecation. Urinary dribbling occurred. Cystoscopy had been performed at the age of two years, but the mother was told that nothing abnormal was found.

On admission, the following pertinent physical findings were noted: The child was small and poorly developed. He weighed only 16 pounds and his behavior was infantile. There was slight micrognathism. The abdomen was protuberant, and fecal material was easily palpated in the bowel. Constant dribbling and overflow from the rectum and urethra were noted, particularly on crying. Sphincter tone was poor, and the rectum was filled with mass-like stool. The rest of the examination, directed primarily toward the field of growth and development, with an evaluation of the gastrointestinal problem, was noncontributory. A proper roentgen evaluation of the pelvis was not possible because of the massive fecal content. The child was discharged with the diagnosis of primordial dwarfism and mental retardation.

The patient was followed in the growth and development clinic for six years. During this time he continued to show retardation of growth, and the

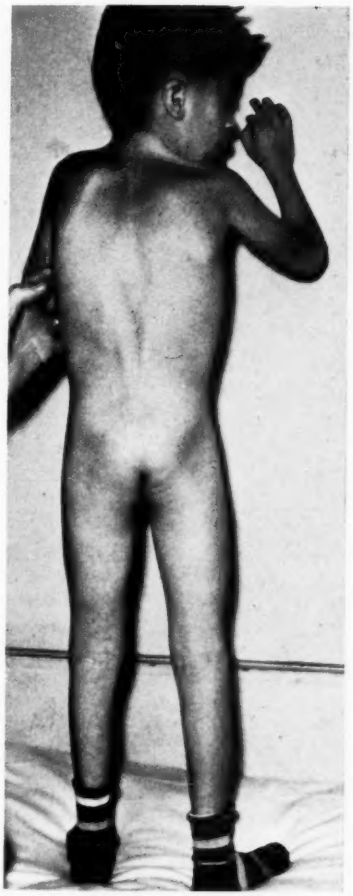


Fig. 5. Case II: The classic features of sacral aplasia are shown in this photograph, with absence or deficiency of gluteal masses, absence of natal creases, a prominent lumbar shelf, and cone-shaped lower extremities.

[2] Dr. John Caffey saw these films in consultation and agreed with this impression.

Fig. 6. Case II: A frontal plane roentgenogram of the lumbar spine and pelvis showing complete absence of the sacrum. There is some obscuration of overlying intestinal content. The pelvis is bilaterally contracted.

urinary and bowel problems persisted. Intravenous urograms obtained on several occasions were reported as normal. On Oct. 7, 1957, a clinical diagnosis of sacral aplasia was made by one of the authors (S. E.). This diagnosis was based on the absence or deficiency of the glutei, a prominent lumbar shelf, and absence of natal creases (Fig. 5). Roentgen studies of the pelvis were repeated (this time with considerably less fecal material in the bowel), and for the first time in this child absence of the sacrum was roentgenographically demonstrated (Figs. 6 and 7).

At this time, a 4-year-old sibling was also examined and found to have marked foreshortening of the trunk, with a severe kyphoscoliosis. A roentgen examination of the spine showed multiple hemivertebrae and rib fusion. The sacrum and coccyx were present. An attempt was made to obtain roentgenograms of the spine and pelvis of the parents, but unfortunately their permission was refused.

This second case is still being followed in the clinic, with no apparent improvement in the fecal and urinary incontinence.

Comment: This case is unusual in that the child was followed for six years before

Fig. 7. Case II: Lateral view of the lower spine area again showing absence of the sacrum.

the diagnosis was made clinically and confirmed roentgenographically. An interesting finding is the appearance of anomalies in a sibling. The association of fecal and urinary incontinence with the sacral aplasia is expected. The relationship of primordial dwarfism to the sacral aplasia is interesting and, although not specifically mentioned in the literature, is not unexpected, since other genetic anomalies are frequently noted with absence of the sacrum.

CASE III: J. M. I., a white boy of 5 1/2 years, was seen in the children's neurology clinic for an opinion concerning a limp and occasional fecal incontinence. The child was a product of a breech extraction delivery. At birth, it was noted that he had a "congenital deformity of the spine" with a nonpigmented hairy nevus.

Roentgenograms were reported to show a "separation of the spines and a distortion of some spines." The parents were told that all that could be done was to observe the child's growth and development. On physical examination, nothing significant was noted except for changes seen on inspection in the lower dorsal and lumbar spine. While standing erect, the child was shown to have a list of the lower spine to the left, with a marked dimpling and concavity in the area of the lower dorsal spine in the midline. There was a left lower extremity limp with a tilt of the pelvis to the left. There was no limitation of bending or any other musculoskeletal deformity. Palpation revealed the typical lumbosacral shelf and a fatty mass in the lumbosacral region. There was flattening of both gluteal masses, especially on the left. No neurologic deficits were apparent on physical examination. On the basis of these physi

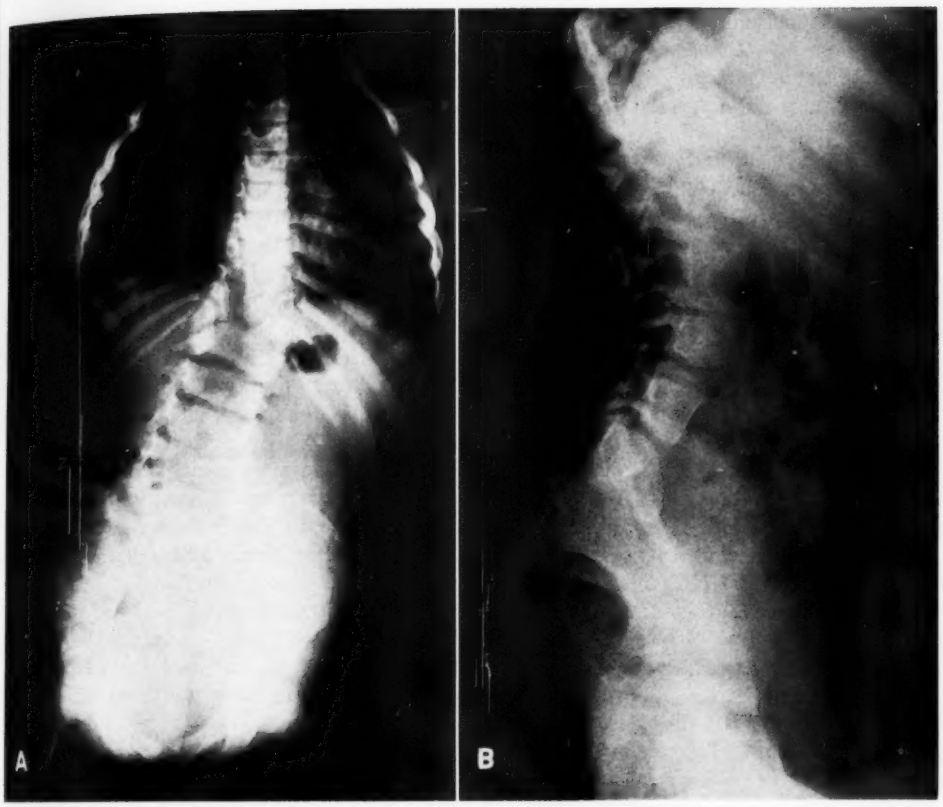


Fig. 8. Case III: A. Frontal plane view of the spine and pelvis showing a marked congenital abnormality of the lower dorsal and lumbar spine with a sharp curvature to the left in the dorsolumbar region. There are hemivertebra formation and "butterfly" vertebrae, with failure of fusion in the posterior neural arches from the lower dorsal spine down through the terminal portion of the spine. Only the first sacral segment is present.
B. Lateral view of the same child showing hypoplasia of the sacrum with the first sacral segment apparent. The centrum of L-3 is markedly flattened; this probably represents part of a hemivertebra.

cal findings, a diagnosis of sacral aplasia was made (M. J. H. G.).

Routine laboratory examinations were noncontributory.

Roentgenograms of the dorsal and lumbar spine showed no abnormality in the upper dorsal region but demonstrated the tilt of the lumbar spine to the left, with an exaggerated lumbar lordosis. There were hemivertebrae, "butterfly" vertebrae, and incomplete fusion of the posterior neural arches from D-7 down through L-5. An anomaly of L-3 was felt to be part of a hemivertebra. The first sacral segment was present but the remaining sacral segments (and coccyx) were absent (Fig. 8). The pelvis was contracted, with a resultant diminution in the transverse pelvic diameter.

Comment: With the experience gained in the first two cases presented above, a clinical diagnosis of sacral aplasia was readily made and confirmed by roentgen study. It is of interest that one of the cardinal features that brought this child for examination was intermittent fecal incontinence.

Etiology: Theories as to the etiology of the inhibitory process having to do with total absence of a segment of the vertebral column include caudal suppression by minute embryonal trauma (6), defects of varying degree in the posterior portions of the metameric segments (7), and "interference with a primary organizer during the early stages of fetal development" (3). Experimentally, different animals have been subjected to various traumata to bring about absence of spinal segments

(8–11). Conceivably, illness, pyrexia, or the presence of "toxic substances" in the maternal circulation might cause lack of spinal segment development (3).

INHERITANCE

Familial and hereditary tendencies in sacral aplasia are suggested in the literature (12, 13). Rumplessness in fowl has been known for three centuries (14) and closely resembles the human disorder; it occurs both as a hereditary anomaly and spontaneously (15–18). An inherited mutant gene may operate in analogous disorders in man.

CLINICAL FEATURES

The appearance of the patient depends on the extent of spinal involvement and the degree of associated changes of neurological and skeletal character. Vertebral and pelvic abnormalities fall into two broad classes. In the first, S-1 is present (Cases I and III) or, failing that, L-5 is sacralized. The bony ring of the pelvis is complete and the weight of the trunk is transmitted normally, or almost so, to the innominates and the femurs. Stance and gait are therefore almost or quite normal. Those cases with the sacrum totally missing make up the second class (Case II). Here there is no sacralized lumbar vertebra, and on rectal and external palpation one feels a ledge at the level of the last lumbar vertebra. In more severe forms, standing and walking are impossible. Since the iliac bones in such instances are in contact, they assume a vertical position, and dislocation of the hips sometimes results (19).

Neurological abnormalities result from interference with development of the spinal nerves in the affected segments. In the vast majority of reported cases there is incontinence of urine; fecal incontinence is less common and tends to improve at puberty. Even in the absence of fecal incontinence, the anal sphincter is usually atonic (3).

The muscles supplied by the nerves of the affected segments are markedly atrophic. This may well be due to muscular hypoplasia or dysgenesis. The muscles are generally quite small. Those primarily involved are the muscles of the perineum (S-2 to S-5), and legs and buttocks (L-5 to S-1). The thigh muscles (quadriceps and adductors) are normal. Thus, there is a characteristic cone-shape to the lower limbs which contributes to flattening of the gluteal convexity with absence of the intergluteal cleft, already noted as being due in part to skeletal changes. In the extreme cases, these total changes have been designated as "siren" or "mermaid" configurations (19).

Sensory changes occur less frequently than motor, while the segmental distribution is less extensive (3). The infrequency of reports of sensory loss may be partly due to the inability of the child to co-operate in the examination.

Orthopedic deformities of the lower limbs occur frequently and are mainly of the paralytic type. Clubfoot is present in a little over one-half the cases. Dislocation of the hips due to vertical placement of the iliac bones is not uncommon.

DIAGNOSIS

The diagnosis of sacral aplasia may be made accurately on the basis of the characteristic clinical and roentgen findings. The important clinical features on examination are: absence of gluteal masses and of gluteal folds; a palpable lumbar shelf; a fat pad over the sacral area; absence of natal creases; cone- or spindle-shaped lower extremities. Urinary and fecal incontinence are usually present. Associated anomalies such as clubfoot, hip dislocation, etc., may be present. The roentgen evaluation of the lower spine in the film of the pelvis is sometimes difficult because of the very marked fecal impaction usually present (see Case II). This should serve to focus attention on the importance of adequate preparation in the roentgen examination where the clinician suspects the diagnosis.

Changes in the urinary tract frequently consist of a cord bladder with hypertrophy of the bladder wall. Additional urinary

tract findings will depend on the presence or absence of infection. The findings on a barium enema study may be normal, aside from the considerable retention of fecal material, but in our Case I, the zones of narrowing with marked fecal retention and dilatation suggested a neurogenic colon.

TREATMENT

Orthopedic treatment is directed to the correction of deformities. The genitourinary problem relates to the control of urinary incontinence and infection. Fecal impaction must be managed in the customary way. Treatment directed to the primary condition of sacral aplasia is obviously not available.

SUMMARY AND CONCLUSION

Three cases of congenital aplasia of the sacrum are presented (1 total and 2 partial), and the literature is briefly reviewed.

The theories of causation of this anomaly are mentioned. Most observers feel that it is produced in fetal life by some noxious influence on the lower vertebral centers.

The clinical and roentgen features are described.

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SUMMARIO IN INTERLINGUA

Aplasia (Agenese) Sacral

Es reportate tres casos de congenite aplasia del sacro, 1 complete e 2 partial. Le majoritate del observatores crede que iste anomalia es le resultato de un influentia noxiose suffrite per le centros infero-vertebral durante le vita fetal.

Le apparentia del patiente depende del grado del affection del columna vertebral e del serietate del associate alterationes neurologic e skeletic. In le formas plus sever del condition, tener se erecte e ambular es impossibile. Anormalitates neurologic es le resultato de un interferentia con le disveloppamento del nervos in le afficite segmentos del columna vertebral. In le grande majoritate del casos il ha incontinentia de urina. Incontinentia fecal es minus frequente. Le musculos servite

per le nervos del afficite segmentos del columna vertebral es atrophic, notabilemente le musculos del perineo e del gambas e del podice. Deformitates orthopedic del extremitates inferior non es incommun.

Le diagnose de aplasia sacral pote esser facite accuratemente super le base del constatationes clinic e roentgenologic. Le importante constatationes clinic es absentia de massas e plicas gluteal, un palpabile processo lumbar, un cossino de grassia supra le area sacral, absentia de plicas natal, e extremitates inferior coniforme o fusiforme.

Roentgenography of Giant Fibroadenoma of the Breast (Cystosarcoma Phylloides)[1]

J. GERSHON-COHEN, M.D., and LOLITA MOORE, M.S.

BREAST TUMORS coming under the category of cystosarcoma phylloides are infrequently encountered. The x-ray observations in a small group found in breast surveys at the Albert Einstein Medical Center in Philadelphia during the past eight years will be presented here.

Some 50-odd names have been given to these giant tumors (6). Müller, in 1838, seems to have been the first to use the term "cystosarcoma" for fibrocystic masses having a sarcomatous texture. He described three forms: the first with a fibrosarcomatous structure, containing smooth-lined cysts; the second like the first variety except that within the larger cysts were younger cysts attached by pedicles; the third, cystosarcoma phylloides, forming a large firm mass with a more or less uneven surface. The fibrous substance which constitutes the greater part of this tumor has a grayish-white color, is extremely hard and as firm as fibrocartilage. Large portions of the tumor are made up entirely of such tissue,

TABLE I: SUMMARY OF OBSERVATIONS ON NINE CASES OF CYSTOSARCOMA PHYLLOIDES

Case and Figure No.	Age and Race	History	Clinical Findings	Pathologic Report
Case I Fig. 1	45 yr. White	Mass noted for two months. Rapid increase in size. Premenstrual enlargement and tenderness	12-cm. mass fixed to underlying tissue. Skin tense and engorged	Cystosarcoma phylloides
Case II	53 yr. White	Mass noted for ten weeks. Increase in size; slightly tender. "Fibrous tumor" removed from same breast three years earlier	8-cm. movable mass. No skin changes noted	Cystosarcoma phylloides
Case III Fig. 2	46 yr. White	Left breast mass for eight years with gradual increase in size	10-cm. mass, tense and bulging. Skin taut and discolored	Cystosarcoma phylloides
Case IV Fig. 3	74 yr. White	Mass noted one month. No change in size. Shooting pains and itching of skin	6-cm. tumor, freely movable and "shotty." Superficial veins prominent	Miniature cystosarcoma phylloides
Case V	55 yr. White	Nontender mass noted for about one year	4-cm. mass, freely movable and well defined	Miniature cystosarcoma phylloides
Case VI	39 yr. White	Mass noted for two months. Gradual increase in size. Tender	3-cm. mass, soft and freely movable	Cystosarcoma phylloides; extensive necrosis
Case VII Fig. 4	44 yr. Negro	Both breasts enlarged six months previously. *Left* breast regressed; *right* continued to grow	Enormous multinodular mass, tender to touch. Skin reddened and warm. Superficial veins dilated	Cystosarcoma phylloides. Extensive necrosis. (Sarcomatous recurrence three months later)
Case VIII Fig. 5	47 yr. Negro	Increase in breast size noted for twelve months. Mass found five months ago; tender. Nipple discharge for fifteen years	11.5-cm. movable mass. Skin discolored and retracted. Palpable axillary nodes	Cystosarcoma phylloides; carcinoma
Case IX Fig. 6	73 yr. White	Nontender mass found five days previously	Irregular, hard, 4-cm. mass. Small satellite tumor	Sarcoma (probably originated from a miniature cystosarcoma phylloides)

[1] From the Department of Radiology, Albert Einstein Medical Center, Northern Division, Philadelphia, Penna. Supported in part by a National Institutes of Health Grant #CS-9490 (C), and by funds of Mrs. Rose Strick made available through the good offices of Dr. Joseph C. Doane, to whom we are grateful for material help and support.
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but in some parts there are cavities or clefts *not* lined with a distinct membrane. Müller never intended to convey the impression that these tumors actually threatened life in the ordinary sense of malignant neoplasms (6).

Cystosarcoma phylloides may be regarded as a giant form of intracanalicular fibroadenoma. However, even a smaller fibroadenoma might be labeled cystosarcoma phylloides if giant intracanalicular projections were present. Some laboratories term these smaller varieties *miniature* cystosarcoma phylloides. Actually the only difference between an intracanalicular fibroadenoma and a cystosarcoma phylloides is one of size and cellularity! Also, in contrast to fibroadenoma, cystosarcoma phylloides has been known to metastasize even though the primary tumor was well encapsulated; after local excision, recurrences have been reported with or without distant metastases.

Cystosarcoma phylloides is a rare tumor presenting a variety of symptoms and clinical findings. Details of our 9 cases are summarized in Table I.

The microscopic picture in Cases I, II, and III was typical of cystosarcoma phylloides. The tumors were large, nodular, and almost entirely encapsulated. Intracanalicular projections and occasional cystic spaces were found on histologic section. On the x-ray film all 3 tumors were smooth-margined and somewhat lobulated (Fig. 1). The general appearance was that of large, but entirely benign, lesions. Giant fibroadenomas are said to grow rapidly, but in Case III there was a history of slow growth over an eight-year interval. Another unusual circumstance in this case was the development of a

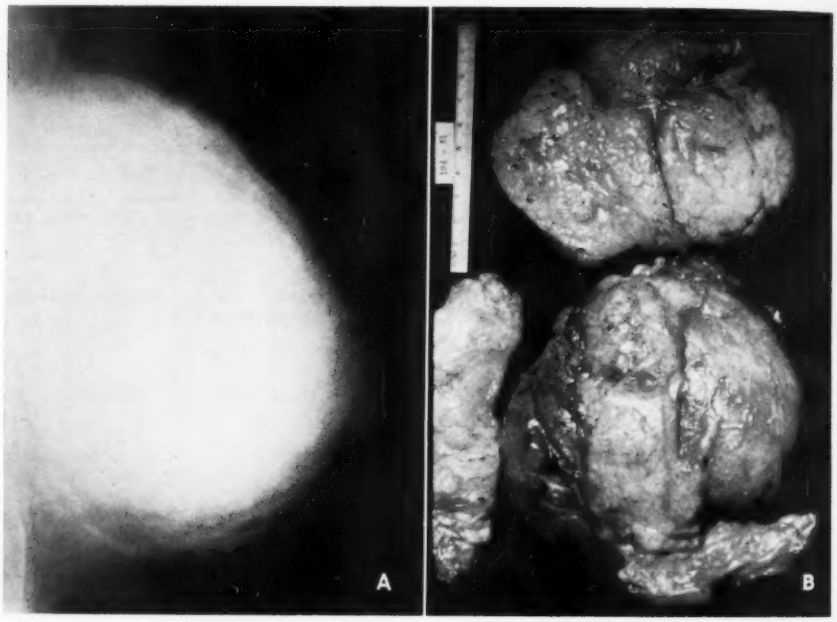


Fig. 1. Case I. A white patient, single, forty-five years old, had for two months been aware of an increasing mass in her right breast. Palpation disclosed a tumor measuring about 12 cm. in diameter, fixed to the subjacent tissues, but not to the overlying skin, which, however, was tense and engorged.

A. The roentgenogram revealed a circumscribed mass occupying practically the entire breast. The smooth contours suggested a benign process.

B. On gross section the tumor was found to be made up of a conglomeration of firm fibromatous nodules, the entire mass measuring 13 × 10 × 6 cm. Histologic studies showed structural changes of a cystosarcoma phylloides.

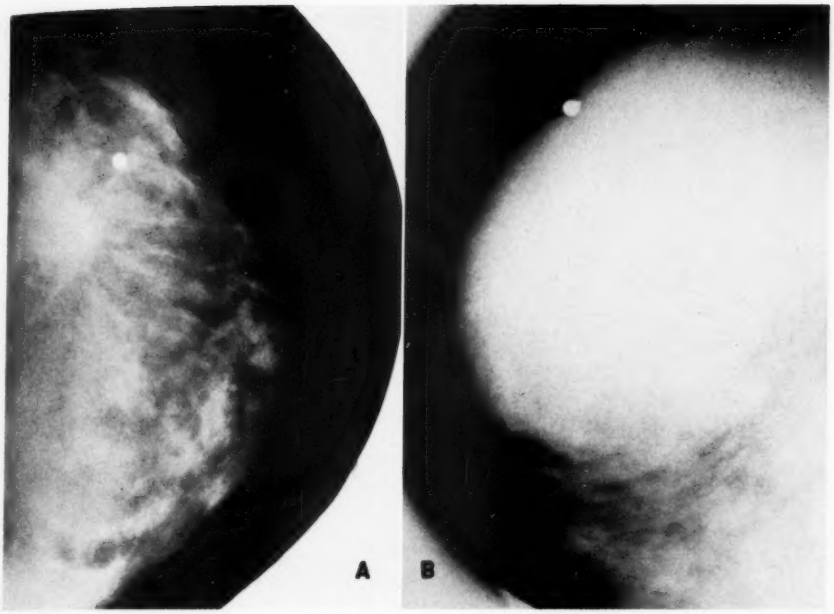
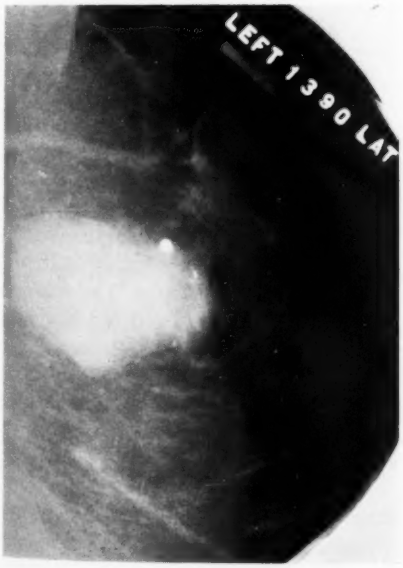


Fig. 2. Case III. A 46-year-old widow had known of a mass in her left breast for eight years, which had seemed to enlarge. She was referred by her family physician for surgical consultation following x-ray studies.

Examination revealed a firm irregular mass about 2.5 × 3.0 cm. in the upper inner quadrant of the *right* breast, which the clinician thought was malignant. In the *left* breast was a tense bulging mass about 10 cm. in diameter over which the skin was taut and discolored. This mass was thought to be a cyst or fibroadenoma.

X-ray studies disclosed a giant fibroadenoma in the *left* breast (B), while in the *right* breast (A) there was a spiculated tumor typical of scirrhous carcinoma.

The right breast was first operated upon (Dec. 9, 1958) and a duct carcinoma with no axillary lymph node metastases was found. A giant fibroadenoma, 10 cm. in diameter, was removed from the left breast two months later.



carcinoma in the opposite breast during a long period of repeated clinical observation (Fig. 2, A).

A clear-cut microscopic picture of cystosarcoma phylloides was also found in Cases IV and V. Because of their small size, the tumors were labeled "miniature" by the pathologist. On the roentgenogram (Fig. 3), they appeared smooth and

Fig. 3. Case IV. A white patient of 74 years had a mass in the left breast, associated with shooting pains and itching of the skin, for one month.

Roentgenography disclosed a sharply circumscribed mass suggesting a benign process, possibly a cyst or fibroadenoma but, because of the patient's age and the undulating margins of the lesion, the possibility of a medullary carcinoma was not ruled out.

A well circumscribed multi nodular tumor 5 × 3 × 2.5 cm. was found at operation. From the microscopic studies, a diagnosis was made of miniature cystosarcoma phylloides. Although there was marked epithelial hyperplasia, it was felt that this component would not lead to future difficulty.

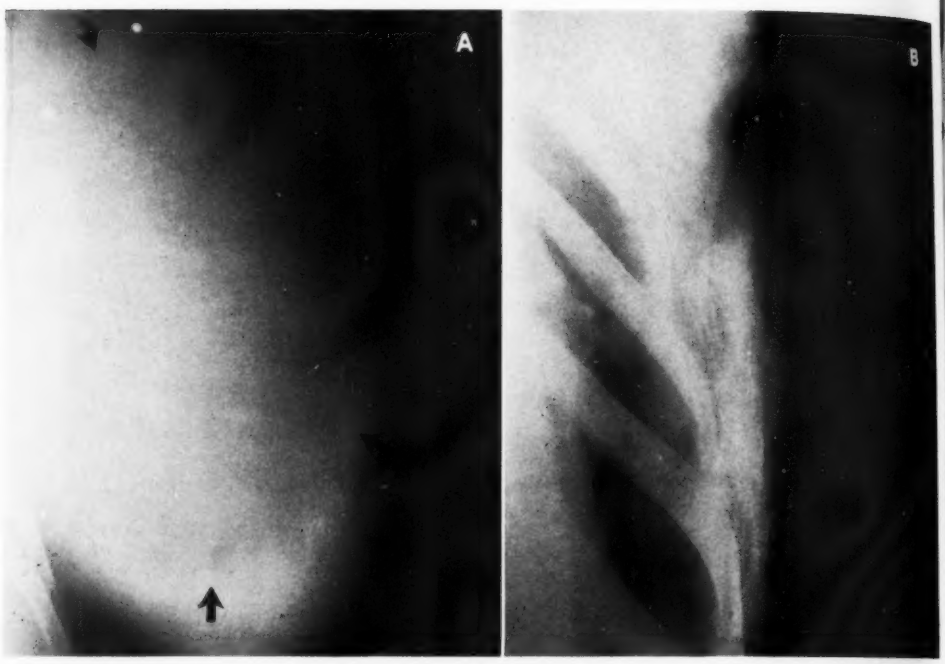


Fig. 4. Case VII. A 44-year-old Negress noticed bilateral breast swelling, regressing on the *left* in one month and progressing on the *right* for six months. The right breast attained an enormous size and was tender to the touch. The overlying skin was warm, the superficial veins were dilated, and the axilla was free of adenopathy.

X-ray study revealed a circumscribed mass with a large central spherical radiolucent area suggesting cystic or myxomatous degeneration of a giant fibroadenoma (A).

A simple mastectomy disclosed a multilobulated, well circumscribed tumor comprised of coalescing nodules varying from 1 to 10 cm. in diameter. A central necrotic area was present, measuring 10 cm. in diameter, corresponding to the radiolucent shadow seen on the film. Histologic examination revealed a giant fibroadenoma-cystosarcoma phylloides.

Three months later the patient returned with a recurrent mass the size of an orange near the upper and inner edge of the scar. A small lump had appeared three weeks before and had grown to this enormous size in the interim.

X-ray examination revealed a solid circumscribed mass about 6 × 10 cm., similar to the original tumor except for the absence of central necrosis or myxomatous degeneration. The underlying muscular structure of the breast seemed to be infiltrated (B).

No cysts were seen on the cut surface. The microscopic picture was that of a fibrosarcoma with obvious infiltration of the skeletal muscle. No epithelial components could be found in this tumor.

could not be differentiated easily from the more common types of mammary fibroadenoma.

The x-ray appearance in Cases VI and VII was unusual. A radiolucent cavity was noted, surrounded by a dense solid peripheral portion (Fig. 4, A). In both cases a central necrotic cavity was found by the pathologist in the corresponding area. Case VII, in which there was a sarcomatous recurrence (Fig. 4, B), with eventual metastases, emphasizes the difficulties that can be encountered in establishing a prognosis in these tumors.

The occasional association of an epithelial neoplasm with cystosarcoma phylloides is not a clearly defined problem. In Case VIII (Fig. 5) both were found to be present at operation. In this instance the roentgen findings emphasized the malignant rather than the benign features. The malignant transformation which occurred in Case IX involved the sarcomatous elements of the growth. Here again the roentgenologist was impressed by the malignant aspect of the tumor (Fig. 6).

DISCUSSION

Roentgenographic aid in the diagnosis of cystosarcoma phylloides can be sub-

Fig. 5. Case VIII. A 47-year-old colored woman was aware of a rapidly growing tender mass in her left breast during a period of five months. The breast had actually first increased slightly in size seven months before the mass was noted but, because both breasts swelled premenstrually, this was ignored. In addition, following a miscarriage fifteen years earlier, a milky discharge was observed intermittently from the left nipple. A movable tumor 11.5 cm. in diameter was found in the outer portion of the left breast with discolored overlying *peau d'orange* skin. Nodes were palpable in both axillae. The findings suggested a malignant lesion.

X-ray studies revealed a mass which looked in part like a benign process due to the smoothness of some of its margins, and in part like a malignant process due to spiculations and extensions into the surrounding tissue.

At operation the tumor was multilobulated, generally solid but containing numerous loculated cystic cavities such as are associated with cystosarcoma phylloides. The pathologist reported a large-cell carcinoma but was uncertain whether or not it originated in a giant fibroadenoma which was also present.

Fig. 6. Case IX. A 73-year-old white widow discovered a mass in her left breast only five days before examination.

An irregular firm mass about 4 cm. in diameter was found in the upper outer quadrant of the left breast, with a small satellite nodule close by. The clinician believed this to be a malignant process.

X-ray examination revealed a tumor about 2 cm. in diameter with saw-toothed margins, suggesting malignancy.

The histologic diagnosis was sarcoma, probably arising from the stroma of a miniature variant of cystosarcoma phylloides. No axillary lymph node metastases were present.

stantial, but not every large, well circumscribed, smoothly contoured tumor is a giant fibroadenoma. Correlating the roentgen and clinical findings is usually easy, since the conclusions tend to be the same, but this is not invariably true. For instance, ordinary large fibroadenomas may resemble cystosarcoma phylloides roentgenographically (Fig. 7). The flaky calcareous deposits commonly seen in fibroadenoma may be helpful in differentiating the two types of tumor.

As noted by Haagensen (4), cystosarcoma phylloides is apt to be found in older persons than is fibroadenoma. Our experience bears this out, but, during the fourth and fifth decades, cysts rather than fibroadenomas are likely to be found. To differentiate the large ones from giant fibroadenomas on the x-ray film may at times be a problem (3).

Finally, the roentgenographic interpretation can be made difficult because of the uncertain conclusions of the pathologist. Lester and Stout (5) tend to put adenofibromatous tumors into the cystosarcoma group if there is an unusually cellular stroma suggestive of sarcoma, or if these

Fig. 7. Large fibroadenoma with flaky calcareous deposits.

tumors grow with exceptional vigor and attain large size even though there is nothing unusual about the adenofibromatous pattern and no areas with a sarcoma-like stroma are found. They exclude from the cystosarcoma group those tumors which have no epithelial components. Thus they can more clearly designate the usual types of sarcoma arising from cells of mesodermal origin such as fibrosarcoma, liposarcoma, myxosarcoma, etc.

Differences of opinion among pathologists are not hard to understand when one remembers the great variation in the histologic structure of cystosarcoma phylloides. A whole gamut is run from pericanalicular cellular adenofibromas, through intracanalicular adenofibromas with giant cellular stroma and flattened epithelium lining distorted ducts, to tumors having no epithelial components because of the marked overgrowth of stroma. The stromal pattern also varies from that of a well differentiated sarcoma to a pronounced anaplasia. Myxomatous areas are frequently encountered, as well as other mixed elements, such as scattered foci of cartilage and lipoblastic changes, probably accounting for the different names associated with these tumors.

Since it is generally conceded that cystosarcoma phylloides is benign, radical therapy is indicated only when malignant changes are found by the pathologist. Such changes should now be looked for by the roentgenologist. Malignant variants probably occur in less than 5 per cent of all these tumors. Treves and Sunderland (7) found 18 malignant cases among 77 patients, although only 9, or 13 per cent, had metastasized. Haagensen reported only 1 of his 36 cases as being malignant, 2.8 per cent. In our series of 9 cases (Table I), carcinoma was present in 1 and sarcoma occurred twice.

SUMMARY

1. Giant adenofibromas are large, rapidly growing tumors labeled by many names, under the general heading of cystosarcoma phylloides, because of the many variations in stromal structure and epithelial proliferation. While the tumors are usually benign, malignant transformations are said to occur in 2 to 5 per cent of the cases. When malignant, the great majority are sarcomatous; only a very small proportion have a carcinomatous component.

2. Roentgenographically, these tumors appear sharply outlined with smooth contours, which may be lobulated. These masses, especially the miniature variety, must be differentiated from fibroadenomas, cysts, and circumscribed carcinomas.

3. Two cases are described in which central cystic degeneration was demonstrated on the roentgenogram, for the first time in our experience.

4. If flaky calcium deposits are seen in a sharply circumscribed uniformly dense mass, small or large, the chances favor a diagnosis of fibroadenoma rather than of cystosarcoma phylloides.

5. If a homogeneous mass has borders which are not uniformly sharp, and the perifocal tissues are indistinct because of

edema or infiltration, then the possibility of cancer must be considered, even though the general spheroid shape of the tumor suggests fibroadenoma or a cystosarcoma phylloides.

ACKNOWLEDGMENT: Our grateful appreciation is extended to Dr. Henry Brody for his aid in reviewing the pathological material in this report.

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SUMMARIO IN INTERLINGUA

Roentgenographia de Fibroadenoma Gigante (Cystosarcoma Phylloide)

Es discutite le constatationes roentgenographic, clinic, e pathologic in 9 casos de cystosarcoma phylloide. Iste tumor pote esser considerate como un forma gigante de fibroadenoma intracanalicular. Le differentia inter le duo es solmente un question de dimensiones e de cellularitate.

Roentgenographia pote esser de adjuta in le diagnose de cystosarcoma phylloide. Iste tumor es visualisate como un acutemente delineate massa con contornos lisie que es a vices lobulate. In 2 del casos del autores, degeneration cystic central poteva esser demonstrate in le roentgenogramma. Quando squamose depositos de calcium es vidite intra un nettemente circumscripte e uniformemente dense massa, sin reguardo a si isto es micre o grande, le probabilitate favora un diagnose de fibrosarcoma plus tosto que de cystosarcoma phylloide.

Si un massa homogenee ha margines que non es uniformemente nette e si le tissus perifocal es indistincte a causa de edema o de infiltration, alora le possibilitate de cancere debe esser prendite in consideration, mesmo si le conformation generalmente spheroide del tumor suggere un fibroadenoma o un cystosarcoma phylloide. Il pare que transformation maligne occurre in inter 2 e 50 pro cento del casos de cystosarcoma phylloide. Iste malignitate es usualmente sarcomatose.

A Fatal Case of Pneumopericardium

Probably Due to a Patent Pleuropericardial Defect[1]

C. V. PATEL, M.D., and A. L. ANAND, M.B., D.M.R.E.

THE FIRST report of congenital deficiency of the pericardium was published by Realdus Columbus in 1559. Other published works in this field are by Moore in 1925 and Rusby and Sellors in 1945. In most instances the defect has been discovered by chance at necropsy, but more recently it has been reported as an operative finding. In the following case the diagnosis was made solely on clinical and radiological evidence.

CASE REPORT

C. A., a 36-year-old barber, was admitted to the hospital on Nov. 19, 1955, with pyrexia of three months duration and a mild intermittent cough productive of approximately 2 ounces of mucoid sputum, occasionally tinged with blood. The past history and family history were noncontributory.

The patient was 5 feet 4 inches tall, and emaciated, weighing only 80 lb. Positive findings were limited to pallor of the skin and mucous membranes, decreased resonance over the left upper half of the chest on percussion, and fine post-tussive râles with bronchial breathing over the left infraclavicular area. Blood pressure was 140 mm. Hg systolic and 76 mm. Hg diastolic.

The sputum was highly positive for acid-fast bacilli. The red cell count was 4,150,000; hemoglobin, 12.8 gm.; erythrocyte sedimentation rate 46 mm. at the end of the first hour (Westergren); white cell count 11,450 per cu. mm., with 64 per cent polymorphonuclears, 27 per cent lymphocytes, 5 per cent monocytes, and 2 per cent eosinophils. Urine was normal and the serologic test for syphilis was negative.

A postero-anterior roentgenogram of the chest revealed patchy confluent densities in the left upper lobe, with a small cavity projected through the second rib anteriorly. The right apex also showed a zone of infiltration.

Treatment was begun with bed rest, streptomycin (1.0 gm. every third day), isoniazid (8 mg. per kg., per day), and general supportive measures. On the seventh day following admission, the patient experienced a sudden pain in the left side of the chest, with pallor, dyspnea, and profuse sweating. Heart sounds were muffled. On percussion there was increased resonance over the precardial area. A

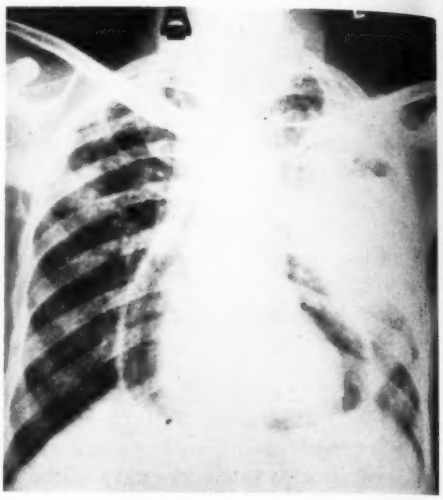

Fig. 1. Postero-anterior roentgenogram of chest taken immediately after the acute episode, showing interlobar hydropneumothorax on the left, with pneumopericardium.

postero-anterior roentgenogram of the chest obtained at this time (Fig. 1) showed a striking change from the small cavity originally seen in the left subclavicular area to an interlobar hydropneumothorax. The cardiac silhouette was distinctly circumscribed by an air-filled sac. A tentative diagnosis of pneumopericardium with mediastino-interlobar hydropneumothorax was made.

A repeat roentgenogram the following morning (Fig. 2) revealed fluid in the pleural cavity up to the fifth rib posteriorly, with pneumopericardium still present. Thoracentesis two days after the acute onset of the syndrome yielded 400 c.c. of fluid, which was found positive for *Mycobacterium tuberculosis*.

The following day, the patient went into an extreme state of shock, and death ensued in spite of intravenous infusions, oxygen inhalation by nasal catheter, and intravenous and intracardiac injection of 1:1,000 epinephrine.

DISCUSSION

There is no doubt that in this case the original lesion was pneumonic cavitation of tuberculous origin. Rupture of the

[1] From the Department of Radiology, K. J. Mehta TB Hospital, Songadh (Saurashtra), India (C. V. Patel, Director; A. L. Anand, Chief of Department of Radiology). Accepted for publication in May 1959.

Fig. 2. Roentgenogram obtained two days before death, showing extension of hydropneumothorax to main pleural cavity, with pyopneumothorax. Thoracentesis yielded 400 c.c. of fluid. Pneumopericardium still present.

cavity into the interlobar pleural space caused interlobar hydropneumothorax, with leakage of air into the mediastinum, leading to mediastino-interlobar hydropneumothorax. Subsequently, through the patent pleuropericardial foramen, the air entered the pericardial cavity, causing pneumopericardium. In the further course of events, pus found its way into the main pleural cavity, producing a pyopneumothorax, which proved fatal.

Pericardial defects are usually associated with abnormalities of the great vessels or ectopic lung segments. The gap most often occurs in the deep or "transverse sinus." Keith claims that the anomaly is due to too rapid growth of the lung bud, resulting in an abnormal dilatation of the iter venosum of Lockwood, following which the pleuropericardial foramen remains patent.

The diagnosis of a large pneumopericardium is obvious. An air-filled sac encircles the cardiac silhouette. Smaller degrees of pneumopericardium may be confused with mediastinal hernia. With pneumopericardium, however, air does not rise above the normal upper limit of the pericardium in the erect position. Moreover, mediastinal hernia shows a significant alteration in size with expiration and inspiration.

SUMMARY

A fatal case of patent pleuropericardial defect, probably of congenital nature, has been described. Its etiology, clinical and radiological manifestations, and differential diagnosis have been briefly reviewed.

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SUMMARIO IN INTERLINGUA

Un Caso Mortal de Pneumopericardio, Causate Probabilemente per Un Patente Defecto Pleuropericardial

Un patiente con un patente defecto pleuropericardial esseva vidite originalmente con cavitation pneumonic de origine tuberculotic. Durante le hospitalisation, le cavitate se rumpeva a in le spatio pleural interlobar, causante assi un hydropneumothorace con infiltration de aere a in le mediastino. Subsequentemente, le aere entrava via le patente foramine pleurocardial a in le cavitate pericardial con le resultato del formation de un pneumopericardio. Pus trovava su cammino a in le cavitate pleural e produceva un pyopneumothorace mortal.

Recording of the Blurring Effect Due to the Vibrations (Lost Motion) in a Linear Tomograph[1]

P. VUORINEN, M.D., S. KAJAS, M.D., and E. SÄRKKÄ

VIBRATION of the x-ray tube during exposure causes an increase in the geometrical blurring in standard roentgenography. Watson has pointed this out, stating that a swaying 1-mm. focal spot can, for example, equal a 4-mm. focus in respect to unsharpness. It is necessary, therefore, to allow a sufficient interval after the tube position has been changed before making an exposure.

In tomography the tube is moving during the whole exposure. Especially in linear tomography, where a heavy mass is abruptly set in motion just before the exposure begins, there is obviously much vibration, especially at the beginning and the end of the procedure. This is known to every one working with a tomograph. This motion, however, has no significance for blurring. Only such movements as cause a deviation of the straight line passing through the focal spot, a point in the pivot plane, and the corresponding film point (R_1 P P_1 in Fig. 1) are able to contribute to unsharpness of the tomographic image, as such a movement, when present, causes the image of a point in the pivot plane to be pictured at different sites on the film (Fig. 1). This unintentional relative movement of the focal spot and film is called by Kieffer "lost motion" and is mentioned by him as an additional blurring factor in tomography. Middlemiss also presents this factor as one among those causing the "unplanned blur." As the cause is not only a possible looseness in linkage between tube and film but may include also bending in the connecting parts, we prefer the expression "vibration/lost motion."

In considering the possibilities for recording the vibration/lost motion in a tomograph, optical means were first thought of, but it soon became evident that x-rays emitted from the focal spot must be used, as the anode plate can have some movement of its own which would otherwise remain undetected. An electrokymograph with a radiosensitive photocell was therefore used for the experiments and the conditions under which a tomogram actually is taken were duplicated.

The experimental arrangements are shown in Figure 2. The photocell (C) was fastened to a sheet of cardboard, which was inserted in the cassette holder of the tomograph. A lead plate with a sharp edge (L) was placed on the tomography table at a suitable height, in such a position that the shadow of the edge fell on the photocell. As is known, the electrokymograph photocell is able to record the movement of the border between a shaded and illuminated area. For this purpose, a second photocell is needed. Since this must be constantly held in the x-ray beam, it was inserted in the primary diaphragm of the tube. The kymographic curves were recorded by a Mingograph (Elema, Sweden).

A Siemens Universal Planigraph was used for the experiments (Fig. 3). This is a tomograph with a linear, parallel movement of the cassette and the tube. The greatest possible exposure angle is 40°, the greatest angle of motion being about 10° more than this. The focus-film distance is constant, 1.5 meters. The exposure always begins after the tube and cassette have been in motion for some time and ends before the motion ceases. The object of this is naturally to exclude the effect of the greatest vibration of the apparatus from the film.

The vibration/lost motion in the direction of the movement, here termed lon-

[1] From the Department of Roentgenology, University Central Hospital, Turku, Finland. Accepted for publication in March 1959.

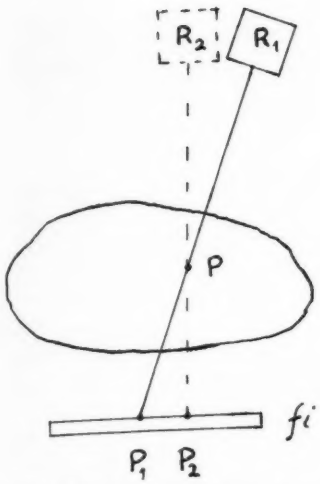

Fig. 1. Origin of the blurring due to lost motion/vibration in a tomographic device. During the exposure, the point P, in the pivot plane of the tomograph, is pictured on the point P_1 of the film. If, then, the tube abruptly gets a momentary advance against the film and swings from R_1 to R_2, the point P is pictured at P_2. This advance can be due to looseness in the connection between tube and film or to bending of some parts. The distance P_1–P_2 represents the blurring of the image of the point P due to this cause.

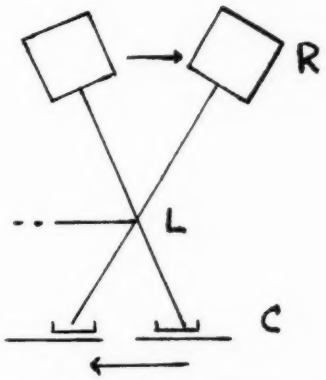

Fig. 2. The experimental arrangement. R. Moving tube of the tomograph. L. Lead plate, the edge of which is in the pivot plane. C. Cassette holder where recording photocell is inserted. If there is a difference in the movement of the tube and the cassette holder, the shadow of the lead plate is not stationary on the photocell and this is recorded.

gitudinal vibration, and that perpendicular to it, transverse vibration, were both registered. For the recording of the former, the edge of the lead plate was placed perpendicular to the direction of the movement, as shown in Figure 2; in the latter case, parallel to it. All speeds possible for this tomograph (the exposure time ranging from 1.0 to 4.5 seconds) were used. The movement of the tube and the cassette holder were always in the horizontal direction. For the longitudinal vibration study, the edge of the lead plate was situated in the pivot plane of the tomograph. This was experimentally tested and easily seen on the curves obtained. For the calibration of the curves, the amplitude of a curve corresponding to the length of the recording photocell was used. This photocell was 15 mm. long in the recorded direction.

The vibration/lost motion was recorded during exposure (20 ma, 60 kv) and, as it was desired to determine the seemingly great vibration at the beginning and end of the movement, recording was done also by using the screening current of the tube (2 ma, 60 kv). This was also important for making a comparison of curves with the anode plate rotating and stationary, as rotation of the anode is known to cause disturbances in electrokymographic recording, if there is any surface roughness. The anode plate does not rotate when the screening current is used. In this instance, there was no difference between the curves obtained with a rotating and a stationary anode, which proves that the surface was faultless (note the evenness of the curve in Fig. 5, C). The tube currents and kilovoltages mentioned above had no direct bearing on the results. Necessary filtration (copper and aluminum) was added between the tube and the recording photocell to bring the output into the range of the electrokymograph.

With the procedure described, it was possible to see on the curves the effect of the vibrations and lost motion during the movement of the tomograph. Figure 4 is a typical transverse vibration curve. Its convex form is due to the variations in distance during the movement, as the course of the tube and photocell were linear. Figure 5(A, B, D, E) shows different longitudinal vibration curves. A represents the lost motion at the be-

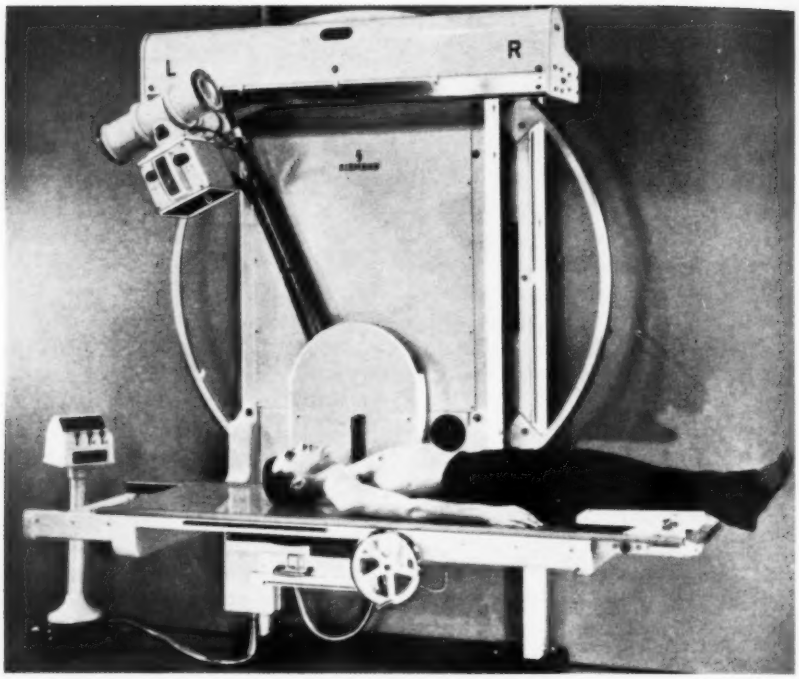

Fig. 3. Siemens Universal Planigraph, which was used in the experiments described.

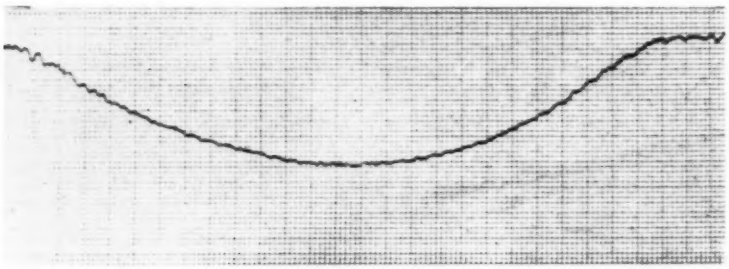

Fig. 4. A vibration/lost motion curve. The lost motion is seen as small wave-formations all along the curve. The acurate form of the curve is due to differences in the focus-photocell distance during the recording. This is a transverse vibration/lost motion curve (see text).

ginning of the movement, B at its end, and D and E at the end and beginning of an exposure. The curve in Figure 5, C was obtained during an exposure with a stationary tube. It is apparent from the curves that, especially at the end of the motion, the staggering is very pronounced, but in all curves, except that in 5, C, there is seen slight wave-formation throughout due to vibration/lost motion.

Measurements were made by comparing the vibration amplitudes to a curve corresponding to the length of the recording photocell. On examination of the curves, the effective longitudinal vibration/lost motion in the beginning of the movement was found to be 0.5 to 0.6 mm. At the end of the movement, when the apparatus was abruptly stopped, lost motion/vibration was much greater, ranging from

TABLE I: RELATIVE VIBRATION/LOST MOTION OF THE FOCAL SPOT AND THE CASSETTE IN RESPECT TO AN OBJECT SITUATED ON THE TOMOGRAPHY TABLE, WITH SIEMENS UNIVERSAL PLANIGRAPH

Phase of the Movement of the Tomograph	The Recorded Effective Vibration/Lost Motion (mm.)	
	Transverse	Longitudinal
Start	0.4–0.5	0.5–0.6
End	1.0–2.0	5.0–6.0
During the movement	0.4–0.5	0.5–0.6

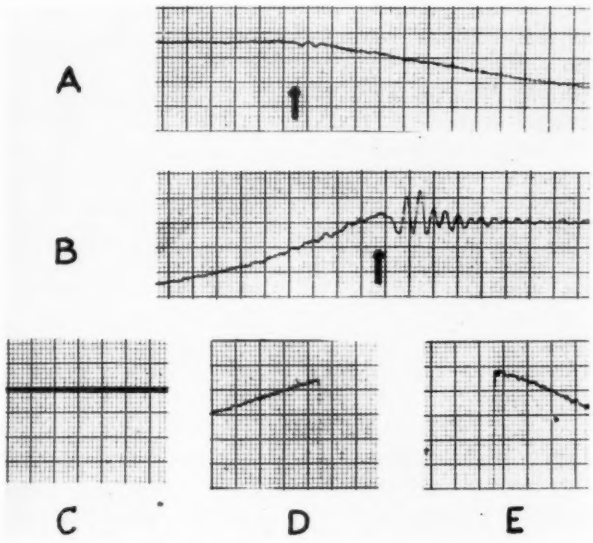

Fig. 5. Longitudinal vibration curves.
A. The arrow shows the beginning of the movement. Two relatively small vibration waves are seen to the right of the arrow, where the movement has begun. Screening current of the tube.
B. The end of the movement. Arrow shows the end of the movement. To the right of this, the staggering occurring with abrupt stoping of the apparatus is seen. Screening current of the tube.
C. Exposition curve with a stationary tube.
D. End of an exposure. The large waves seen in Fig. 5 B are here excluded.
E. Beginning of an exposure.

5.0 to 6.0 mm. The transverse lost motion/vibration was less: in the beginning, 0.4–0.5 mm.; at the end of the movement 1.0 to 2.0 mm. These results are also shown in the accompanying table.

During the movement, longitudinal vibrations of only 0.5 to 0.6 mm. and transverse vibrations ranging from 0.4 to 0.5 mm. were recorded. Thus, no remarkable difference between the transverse and longitudinal vibration/lost motion during the movement was observed. This seems to indicate that these waves are due to a real lost motion (caused by the chains and toothed wheels of the driving mechanism), whereas the greater staggerings, especially in longitudinal direction, at the end of the movement are probably at least partially the result of true inertia forces. This explains also why these waves were much greater in the longitudinal direction. There was no remarkable difference in the recorded waves at different speeds of movement. The lost motion waves tended to be slightly more pronounced during the first part of an exposure. This is explained by the fact that the effect of the initial staggering has a tendency to be somewhat continued, whereas the effect of the swaying at the end of the movement could not affect the apparatus during the movement. The recorded waves always increased in the oblique positions of the tube and cassette

holder. By taking exposure curves, it could be seen that the actual initial and terminal staggerings were always effectively excluded in the tomograph employed.

On the ground of these experiments, it can be concluded that the blurring due to vibration/lost motion in the Siemens Universal Planigraph is of no great importance. The effective vibration/lost motion during an exposure varies from 0.4 to 0.6 mm., *i.e.*, a focal spot of 1.2 mm., for example, can be at the most increased to 1.8 mm. It seems probable, however, that not all tomographs are as stable and of as solid structure, especially the many tomographic devices which are constructed by adding parts to an ordinary radiographic table. In such cases the method here presented offers a means of studying the vibration/lost motion phenomenon.

SUMMARY

The blurring effect due to the vibration/lost motion in a linear tomograph (Siemens Universal Planigraph) was studied with the x-rays from the focal spot of the tomograph tube and a radiosensitive photocell as a substitute for the film. The vibrations having effect on the film ranged from 0.4 to 0.6 mm. The unintentional blurring due to this cause seems to be insignificant.

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SUMMARIO IN INTERLINGUA

Registration del Effecto Obfuscatori Causate per le Vibrationes (Motion Perdite) in Un Tomographo Linear

Le effecto obfuscatori causate per le vibration in un tomographo linear (Planigrapho Universal Siemens) esseva studiate con le radios X ab le spot focal del tubo del tomographo e con un photocellula radiosensibile como substituto pro le pellicula. Le vibrationes que habeva un effecto super le pellicula variava inter 0,4 e 0,6 mm. Le non-desirate obfuscation effectuate per iste causa pare esser non-significative. Tamen, il pare probabile que non omne tomographos es tanto stabile como illo usate in le presente studio. Isto vale specialmente pro dispositivos tomographic construite per adder elementos a un ordinari tabula radiographic. In tal casos le hic-presentate methodo permitte le studio de vibration/motion perdite.

A Technique for Large-Field, Superficial Electron Therapy[1]

C. J. KARZMARK, Ph.D., R. LOEVINGER, Ph.D., R. E. STEELE, Ph.D., and M. WEISSBLUTH, Ph.D.

THE APPLICATION of electron beams to radiation therapy has received increased attention in recent years. This interest stems largely from the special characteristics of the electron depth-dose distribution; the fall-off in depth dose near the end of the range of the electrons is particularly rapid for electron beams having energies less than about 10 Mev. Such an electron beam is suitable for the treatment of widespread, superficial lesions, where it is desirable to minimize the dose to deep tissues. All the common sources of supervoltage x-rays, apart from radioactive substances, are inherently capable of producing an external beam of electrons, though with varying degrees of complexity.

Electrons of about the energy suitable for superficial therapy (several Mev) may be used to produce an x-ray beam which is sufficiently penetrating for the treatment of even the deepest lesions. The Stanford medical linear accelerator was designed to provide both x-rays and electron beams. The accelerator and its application to x-ray therapy have been previously described (1–4). The present report considers large-field electron therapy applications. With the techniques and apparatus to be described, it is possible to change from x-ray operation to electron operation, or *vice versa*, in approximately five minutes.

The measurement of dose distributions confined to a depth of about 1.0 cm. requires special dosimetric techniques, which are also described.

TREATMENT TECHNIQUE

The physical arrangement for electron therapy must be consistent with the following considerations:

1. Patients with superficial lesions frequently require irradiation over large areas of the body surface; in extreme cases the total area of the skin may require treatment. Acceptable uniformity of dose over the treatment area must be maintained.

2. The electron flux which reaches the treatment surface will be accompanied by a supervoltage x-ray background. Since in many situations this will constitute total-body irradiation, its contribution must be kept low.

3. In general, it is necessary to use the same machine for both x-ray and electron work. Consequently, it must be possible to make the changeover from one type of beam to the other rapidly and conveniently.

4. The technique should not impose severe demands on the size of the therapy room or its arrangement. Requirements in respect to the motion of the accelerator mount should be compatible with those for x-ray therapy.

A translation technique has been reported for electron therapy of large areas, with a beam directed vertically downward. In the arrangement used at the Massachusetts Institute of Technology (5, 6) in association with the Lahey Clinic, the electrons were scattered and collimated; while in the arrangement used at the National Institutes of Health, the electrons were magnetically scanned so as to cover an area a few centimeters wide and about 50 cm. long. By translation of the recumbent patient at a suitable velocity beneath such a beam, a given body surface can be treated to a predetermined dose. These techniques which allow treatment in the reclining position are particularly convenient for infirm patients. The space requirement tends to be large, however, since a minimum clear distance of 12 feet is required for translation of a 6-foot patient.

[1] From the Department of Radiology, Stanford University School of Medicine, Palo Alto, Calif. This work was supported by grant DRG443 from the Damon Runyon Memorial Fund for Cancer Research, and in part also by grant C-1566(C5) from the National Cancer Institute, National Institutes of Health, U. S. Public Health Service. Presented at the Forty-fifth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 15–20, 1959.

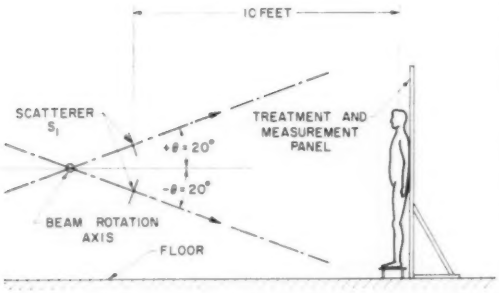

Fig. 1. Geometry of the symmetrical, two-field treatment technique.

In addition, stringent requirements are placed on the constancy of the output from the accelerator and the velocity at which the patient is transported. After experimentation with similar methods, it became apparent that these were not practical in our installation, mainly because of the dual requirements of x-ray and electron therapy with one machine.

In our present technique of electron irradiation, the electron beam is brought out through an existing x-ray defining system and then scattered by passage through a thin foil. The patient stands about 10 feet from the end of the accelerator, and the entire exposed surface is irradiated simultaneously by the broad electron beam. The treatment of a particular body surface consists of two parts—one with the axis of the accelerator directed above the patient's head and again with the axis directed below the patient's feet. The geometry of this treatment technique is shown in Figures 1 and 2.

The combination of the two fields results in a highly uniform dose distribution over the entire height and width of the patient. With simultaneous exposure of the entire body surface, the techniques of dose-rate integration familiar in x-ray therapy may be employed. The average x-ray background dose to which the body is exposed is appreciably less than 1 per cent of the

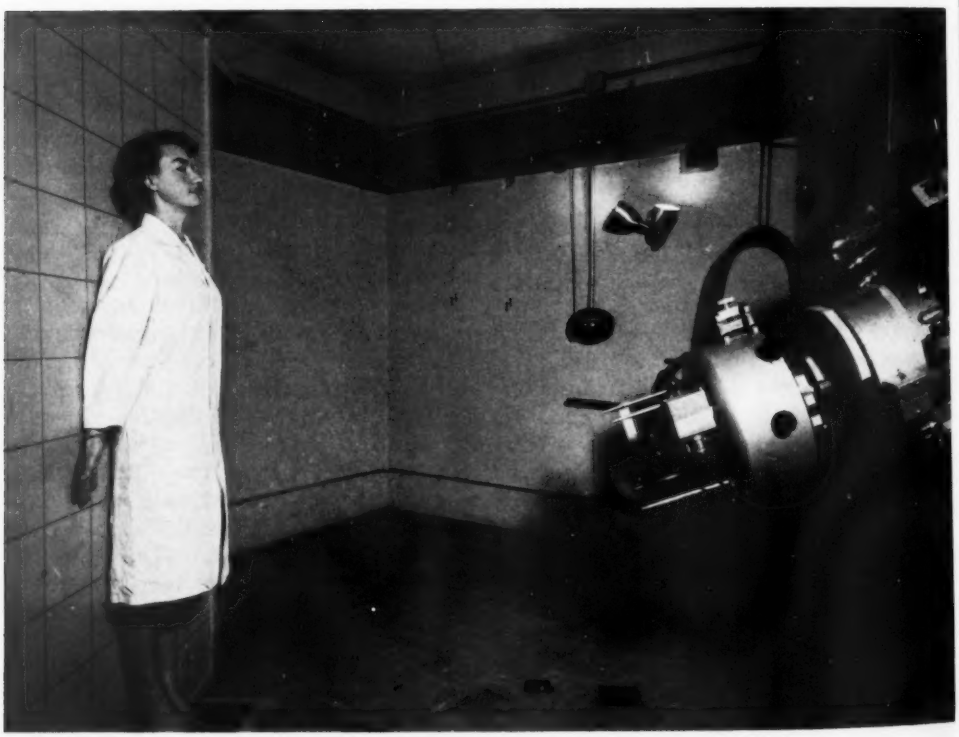

Fig. 2. Treatment set-up. The target-changer knob may be seen to the upper right.

maximum of the electron dose. The conversion to and from electron therapy is simple and readily accomplished by therapy technicians. On the other hand, for infirm patients the upright position may be undesirable, and the patient-shielding problems are somewhat more difficult than in the translation technique. Also, the accelerator must be capable of operating at an energy of 1.5 Mev in excess of that required for tissue penetration, to compensate for the energy lost by the electron beam in traversing the air path to the treatment plane. With the collimation and scattering system described below, the average dose rate in the treatment plane is about 60 rads a minute.

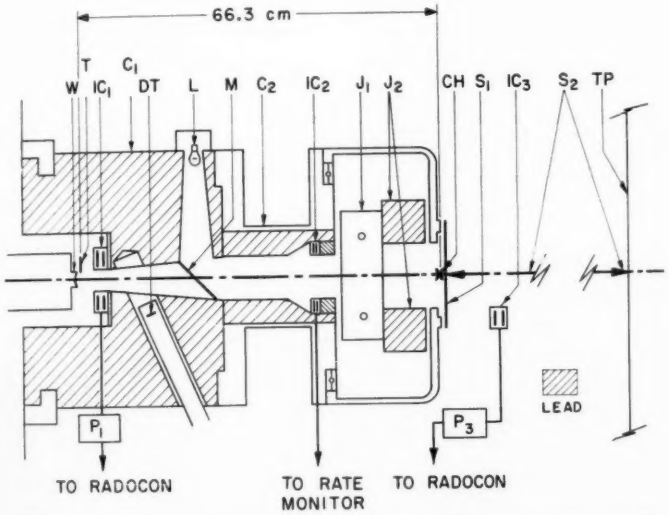

Fig. 3. Collimator assembly. W: 0.0075-inch titanium window. T: Retractable target filter assembly (shown in retracted position). IC_1, and IC_2: Annular ionization chambers (for x-rays). C_1: Lead collimating assembly. DT: Retractable diagnostic x-ray tube used for localization procedures (shown in retracted position). L: X-ray field light. M: 0.020-inch aluminum mirror. C_2: Lead collimator extension. J_1 and J_2: X-ray collimation jaws (shown in retracted position). CH: Cross-hairs. S_1: External 0.037-inch aluminum scatterer. IC_3: Electron monitor ionization chamber. P_1 and P_3: Preamplifier for IC_1 and IC_3. S_2: 10-foot diffuse air scatterer. TP: Treatment and measurement plane.

COLLIMATION AND MONITORING

The collimating end of the accelerator, which contains various monitoring devices and alignment aids, was modified so as to be consistent with the two modes of operation. Pertinent elements traversed by the electron or x-ray beam are illustrated in Figure 3.

The electron beam travels along the axis of the accelerator and emerges from the accelerating tube through a 0.0075-inch-thick titanium window, *W*. The x-ray target *T* is shown in the retracted position. The cone of electrons (or x-rays) is defined by lead collimators C_1 and C_2. The lead jaw system J_1, J_2, used for defining rectangular x-ray fields, is shown in the full open position, as for electron therapy. Mirror *M*, 0.020-inch-thick aluminum, is oriented at 45° with respect to the beam axis. The cross-hair system *CH* (employed with x-ray techniques) consists of a pair of 0.024-inch steel music wires and a 0.0005-inch-thick Mylar dust cover.

For electron therapy an assembly consisting of external scatterer S_1 (0.037-inch-thick aluminum), electron monitor ionization chamber IC_3, and associated preamplifier P_3 is fastened to the front of the x-ray collimator; the chamber is located

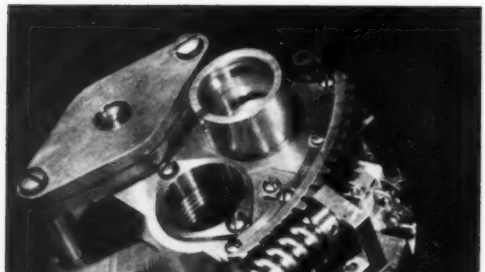

Fig. 4. Target-retracting assembly. The unit is in position to transmit electrons.

in the peripheral field of electrons scattered from S_1. In order to minimize energy dependence, the wall of the chamber facing the beam is of a thickness sufficient to produce approximately maximum build-up of ionization. The output from preamplifier P_3 is fed to an instrument which indicates (in arbitrary units) both dose rate and integrated dose.[2] The notation S_2 refers to the 10-foot thickness of air which serves as a diffuse electron scatterer and which separates scatterer S_1 from the treatment plane TP. Several items shown in Figure 3 are associated with x-ray operation. Their design was dictated in part by the requirement for an efficient changeover procedure from one type of beam to the other.

A target-changing assembly which allows rapid removal and replacement of the x-ray target is shown in Figure 4. A pivoted triangular brass sector, which carries the target-filter subassembly and electron opening, has attached to it a small section of worm wheel. The latter is actuated from outside the collimator through a worm and flexible shaft. Excessive temperatures in the brass sector are avoided by use of a large bearing area to provide good heat

[2] Radocon, manufactured by the Victoreen Instrument Company, Cleveland, Ohio.

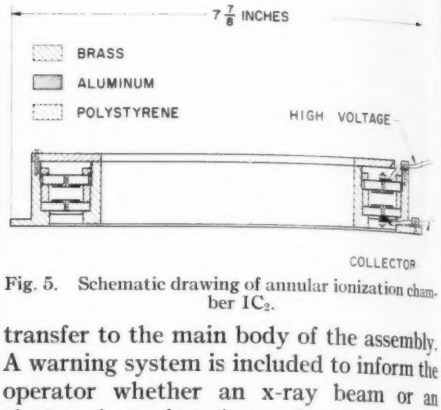

Fig. 5. Schematic drawing of annular ionization chamber IC_2.

transfer to the main body of the assembly. A warning system is included to inform the operator whether an x-ray beam or an electron beam is to be produced. In addition, there is an interlock arrangement incorporating duplicate switches[3] which makes it mandatory that certain safety procedures be carried out.

In order that the monitoring instruments associated with the x-ray beam not interfere with the electron beam, annular ion chambers IC_1 and IC_2 (Fig. 3) were designed. Chamber IC_2 is shown schematically in Figure 5. The annular form of ionization chamber was adopted because it eliminates obstructions to the electron beam as well as to the light beam which is employed for localization during x-ray therapy. Moreover, such chambers lend themselves to rugged mechanical construction. Adequate thickness of brass protects the polystyrene insulation of these chambers from direct electron bombardment. Since the ionization chambers sample off-axis flux, their response is moderately dependent on x-ray energy, a fact which has caused no difficulty under our mode of operation. In order to minimize dependence on x-ray field size, it was necessary to shield chamber IC_2 against the back-scattered radiation from jaws J_1.

Except as otherwise noted, the data presented herein were obtained in the absence of mirror M and the collimator extension C_2. It was determined that the inclusion of these two components made no significant changes in the data.

[3] Microswitch type V3-1301. These switches are constructed of a high-temperature, radiation-resistant insulation.

ENERGY-LOSS AND SCATTERING CONSIDERATIONS

The Stanford accelerator is capable of accelerating electrons up to energies of about 6 Mev with an average current of about 20 microamperes. For electrons with energies of several Mev, the stopping power is about 2 Mev for each gm./cm.^{2} Thus the maximum possible penetration of 6-Mev electrons in unit density material of low atomic number (*e.g.*, tissue) is 3 cm. Because of multiple electron scattering, the depth which can be treated with a reasonable uniformity is more nearly half that value. Since the electron energy can be adjusted to values lower than 6 Mev, the treatment depth may be varied to a maximum of about 15 mm.

Table I lists the contributions to energy loss and multiple scattering from the elements traversed by the electron beam for an estimated incident energy of 4 Mev on window W. The energy losses represent minimum values, since the electron path lengths will be somewhat greater than the material thicknesses. The multiple scattering computations are to be used with caution, since scattering from the surface of collimators, apertures, etc., has not been taken into account.

TABLE I: ENERGY LOSS AND MULTIPLE SCATTERING DATA

System Element	Thickness and Material (inches)	Energy Loss (7) (Mev)	Thickness (radiation lengths)	Scattering Angle θ_{rms} (8) (degrees)
Window W	0.0075 Ti	0.12	0.0055	12.8
Mirror M	0.028 Al	0.29	0.0078	16.3
Scatterer S_1	0.037 Al	0.39	0.0105	20.5
Scatterer S_2	120 air (NTP)	0.68	0.0105	22.3*
TOTAL OF ABOVE		1.48	0.0343	...
Scatterer	0.0021 Pb	0.09	0.0105	20.5

*Computed on basis of condensed scatterer.

The choice of aluminum for a scattering material was arbitrary. A given thickness in radiation lengths of any material will produce approximately the same scattering angle and quantity of x-ray background. The associated energy loss, however, will be less for material of high atomic number. For example, a 0.0021-inch lead foil will produce the same scattering angle as the 0.037-inch aluminum foil, but the energy loss in the lead will be 0.09 Mev in comparison with 0.39 Mev for aluminum.

It is noteworthy that the 10-foot air path S_2 is the major source of energy loss and multiple scattering. A fraction of the electrons which are scattered at large angles from aluminum scatterer S_1 are scattered back into the treatment area, mainly into the peripheral regions, by the air scatterer S_2. This effect is not objectionable and, in fact, improves the uniformity of dose across the treatment field. The principal effect of scattering by window W and mirror M is to reduce the flux of electrons available to scatterers S_1 and S_2 and hence to the treatment plane TP, while increasing the x-ray background.

MEASUREMENT TECHNIQUES AND DOSIMETRY

For purposes of therapy one needs to know the distribution of dose both in depth and over the treatment field. Some, but not all, of the techniques which have been developed for the study of dose distributions associated with x-ray beams may be employed here. The small depth of penetration imposes severe restrictions on some of the methods.

For measurements in the treatment plane it was found convenient to establish a system of co-ordinates by erecting a large sheet of plywood perpendicular to the horizontal beam axis. A grid of 20-cm. squares was outlined on this surface. In the discussion that follows, a rectangular co-ordinate system is used, the origin of which is at the midpoint of this plane. The x direction is horizontal, y vertical, and z normal to the plane.

During the course of this investigation, the following dosimetric devices have been used: film, Faraday cup, deflection magnet, extrapolation ionization chamber, ferrous sulfate chemical dosimeter, and a thimble ionization chamber. Films were employed to obtain rapid qualitative information. Relative depth dose was procured by sandwiching small occlusal films

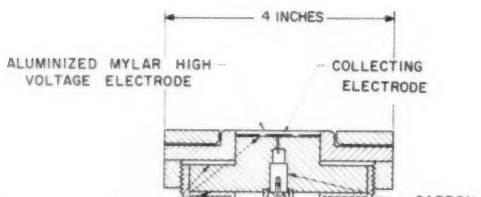

Fig. 6. Schematic drawing of extrapolation ionization chamber. The depth of the collecting volume is varied by turning the large threaded brass ring. The thin front-surface electrode is aluminized Mylar, 2 mg./sq. cm. thick.

between Masonite sheets and exposing them edge-on to the electron beam. Treatment-field uniformity was evaluated rapidly by exposing simultaneously a number of such films located in the treatment plane. X-ray background at phantom depths beyond the electron range was determined with personnel radiation monitoring films. Results obtained with film were in good agreement with other, more precise techniques.

A small Faraday cup was used to measure the flux transmitted by a sequence of aluminum foils. The extrapolated range obtained in this manner gave an energy (9, 10) in good agreement with the mean energy computed from magnetic deflection measurements. For this comparison, the magnetic spectrometer and the Faraday cup were used to measure the energy of the electron beam emerging from the accelerator window. When located at the treatment position, the Faraday cup may also be employed to provide an estimate of surface dose.

The most convenient device for relative and absolute dose measurement has been the extrapolation ionization chamber (11). The chamber, shown schematically in Figure 6, was placed at various positions in the treatment plane with the axis of the collecting electrode parallel to the horizontal axis of the beam. A series of polystyrene-absorbing disks were placed over the front surface of the chamber, and the relative depth-dose distribution was obtained by plotting the normalized ionization current *versus* the thickness of added polystyrene absorber. It is assumed that the true ionization current is the average of the currents measured with both polarities of collecting voltage, that the mass-stopping power ratio between polystyrene and air is not a function of depth of penetration, and that the mass-stopping power ratio is that for electrons of energy equal to that of the primary electrons. The saturation current measured under circumstances which satisfy the cavity ionization conditions of the Bragg-Gray theory may then be interpreted in terms of absorbed energy (*i.e.*, dose in rads) in the usual way (12). The tissue equivalence of polystyrene is based on the fact that the mass-stopping power of polystyrene differs by a few per cent at most from that of tissue (7, 12).

The ferrous sulfate dosimeter has been employed in our laboratory as a standard for the determination of absorbed dose for 4-Mevp x-rays (2, 13). The sources of error and the techniques of measurement have been described in detail (13). For the electron work described here, the same system with a G value of 15.5 (14) was used.[4] The chemical dosimeter results were corrected to take into account the difference in the mass-stopping power between tissue and the dosimeter solution (0.8N sulfuric acid).

Absolute dose values computed from extrapolation-chamber measurements and from chemical dosimeter determinations agreed within 1 per cent. It is likely that this agreement is partly fortuitous, since in both methods errors as large as 1 per cent may arise.

In addition to absolute measurements, it has been possible to obtain depth-dose curves with the chemical dosimeter by use of a broad, shallow polystyrene container

[4] G = number of ferrous ions converted to ferric ions per 100 ev of absorbed energy.

(50 mm. in diameter and 2 mm. deep) and overlaying it with a series of polystyrene absorbers. This is particularly useful for pulsed beams with high-peak dose rates, since the ferrous sulfate dosimeter is independent of dose rate to at least 10^6 rads per second (14) and probably to 10^{10} rads per second (15).

A troublesome source of error was encountered with these broad, shallow plastic containers. There was apparently a diffusion of some substance into the dosimeter solution at a rate which gave an optical density increase (at 3,050Å) equivalent to an exposure rate of approximately 5 rads per minute for the container described above. This effect was not removed by even the most careful cleaning, but was reduced by coating the polystyrene with a silicone. When Ceresin wax was used as the coating agent, the effect became too small to measure (less than the equivalent of 0.1 rad per minute). It was found that the coating could not be omitted in low dose rate (about 30 rads per minute) measurements even if unirradiated control samples were used. The impurities from the polystyrene produced an increase in the apparent G value despite the presence of 10^{-3}M NaCl in the dosimeter solution.

DEPTH-DOSE AND ISODOSE DISTRIBUTIONS

The depth-dose characteristics are determined mainly by the energy of the electrons. This in turn is governed by the microwave power injected into the accelerator, and the latter quantity is controlled by the voltage applied to the klystron which produces the microwave power. Thus, although the electron energy is not known with precision unless additional measurements are made, it can nevertheless be controlled and reproduced. A series of depth-dose measurements was therefore made at various settings of the klystron voltage until a distribution which satisfied the medical requirements was obtained.

The central-axis depth-dose curve measured at point (0,0) with a normally-incident horizontal beam is shown in Figure 7.

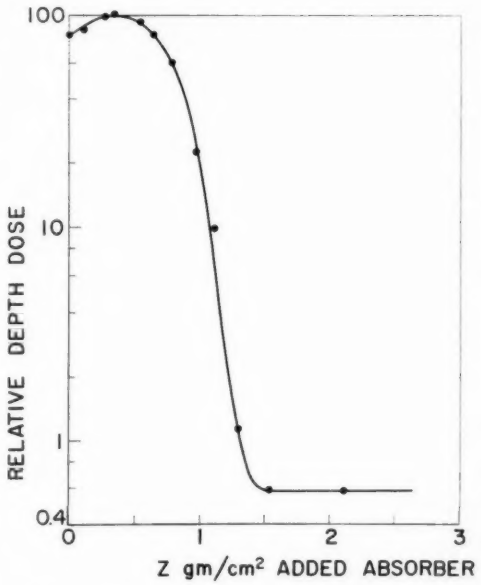

Fig. 7. Central-axis depth-dose curve in polystyrene. The measurements were made with a horizontal beam directed at point (0, 0) on the treatment panel, using the extrapolation chamber. The external scatterer S_1 was 0.037-inch aluminum.

The electron-energy spectrum incident on the treatment plane has not been directly measured, but it may be estimated from Figure 7 that the incident beam has an energy of approximately 2.5 Mev (9, 10). The characteristic rapid fall-off of dose with depth is to be noted, together with a surface dose of approximately 80 per cent and an x-ray background of about 0.5 per cent.

An isodose distribution in the y-z plane for $x = 0$ is shown in Figure 8. It has been computed from a number of depth-dose curves taken at various points along the y axis in the $x = 0$ plane, all normalized to the peak of the (0,0) depth-dose curve. Ideally this distribution would be a series of straight lines parallel to the incident surface line. The departure from this ideal distribution in Figure 8 stems from a number of sources. The number of electrons crossing unit area [illegible] treatment plane decreases w[illegible] from the central axis bec[illegible] both multiple scattering and th[illegible] dence on distance

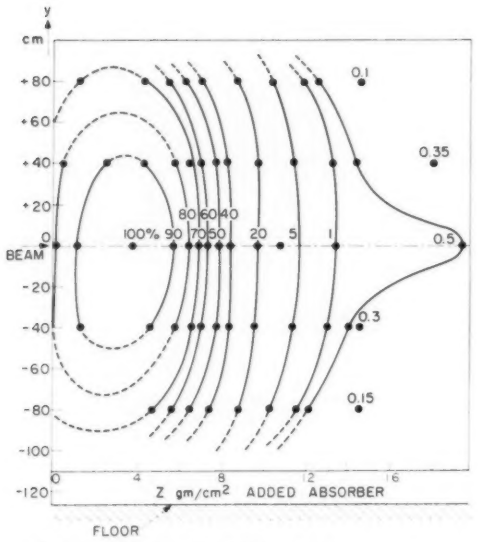

Fig. 8. Isodose distribution in the x = 0 plane Computed from depth-dose curves similar to those in Fig. 7, but taken at various points in the treatment plane. Dashed portions of the curves are extrapolations.

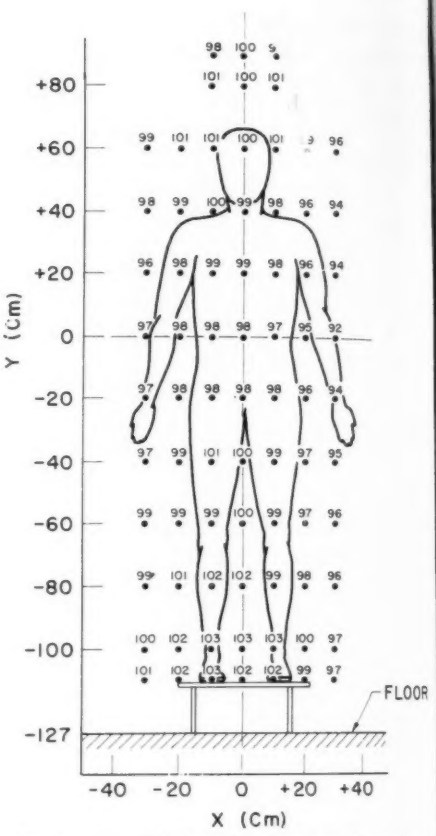

Fig. 9. Composite dose distribution in the treatment plane from two beams at ±20° normalized to 100 at the points (0, ±60). The measurements were made at a depth of 0.34 gm./sq. cm. polystyrene. The external scatterer S_t was 0.037-inch aluminum.

(roughly inverse square with respect to the scatterer). In addition, an electron must travel an increasing distance to reach a given depth below the surface as the angle with respect to the central axis is increased. All these effects tend to shift the off-axis isodose distribution nearer to the surface. The peaked shape of the 0.5 per cent isodose curve indicates that the x-ray background falls off markedly with angle as one departs from the central axis because of the pronounced forward direction of production of high-energy x-rays. A slight asymmetry in the entire pattern exists above and below the central axis. The relative dose is somewhat greater below the axis; this is attributed to scatter from the floor.

The degree of uniformity shown by the isodose distribution of Figure 8 was judged to be inadequate for giving a single uniform dose to the entire body of a patient (approximately 180 cm. high), although the uniformity across the body width would be adequate. Consideration was given to making use of only the central portion of this distribution by employing a large-aperture shield, but this idea was abandoned because of the clinical problems involved in determining the dose at the boundary of adjacent (or overlapping) fields.

With the treatment technique illustrated in Figure 1, two isodose distributions of the type shown in Figure 8 are combined to give a more uniform dose distribution over the height co-ordinate y. The treatment then consists of two equal exposures, the first with the central ray at an angle θ above the horizontal and the second at the same angle θ below the horizontal. The midpoint in the treatment plane receives equal contributions from the two fields. The effect on the spatial distribution of using the symmetrical two-field technique can

be described as fo ws: For θ equal to zero, the isodose plot i Figure 8 is applicable; as θ is increased the peak broadens slowly and gradually s ifts to a symmetrical distribution with two broad peaks. The distribution in the treatment plane for $\theta = \pm 20°$ is shown in Figure 9. This was

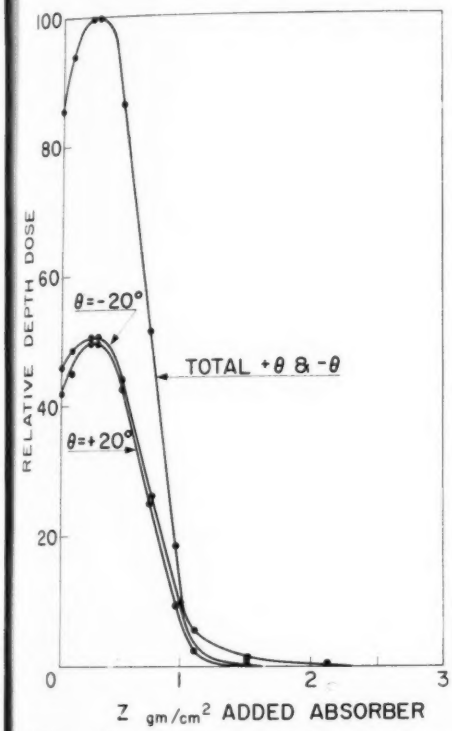

Fig. 10. Depth-dose curves in polystyrene for the two-field treatment technic at (0, 0). The curves give the individual and the composite depth doses for the conditions of Fig. 9.

obtained with the extrapolation chamber, using a polystyrene absorber corresponding to the maximum of the depth-dose distribution. The relative dose-rate values shown in this figure have been arbitrarily normalized to 100 at the points $(0, \pm 60)$. The high degree of uniformity over this large area permits easy positioning of patients of various sizes. The up-down and left-right asymmetry is associated with scattering by the floor and by treatment-room equipment.

Depth-dose curves were evaluated at several points in the $x = 0$ plane by adding

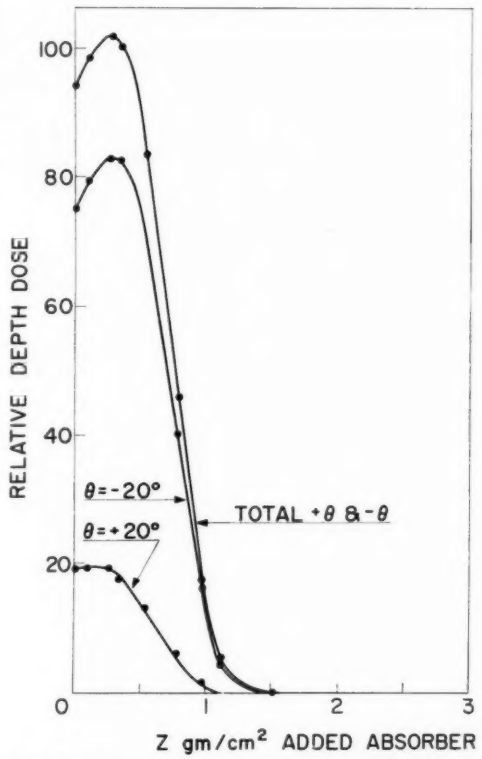

Fig. 11. Depth-dose curves for the two-field treatment technic at (0, −80). Conditions the same as in Fig. 10.

the two contributions for $\theta = \pm 20°$. The individual and composite depth-dose curves are shown for the representative points (0,0) and (0, −80) in Figures 10 and 11. From these curves it is concluded that widely-scattered electrons, which arrive at the treatment plane with incident angles differing appreciably from 90°, produce depth-dose curves which differ somewhat from that shown in Figure 7. The relative surface dose rises, a broader maximum occurs at a slightly shallower depth, and the x-ray background is reduced.

X-RAY BACKGROUND

The electron flux reaching the treatment plane is accompanied by x-rays manifesting themselves as the slowly attenuated tail of the depth-dose curve. Since superficial electron therapy often involves most or all of the body surface, the con-

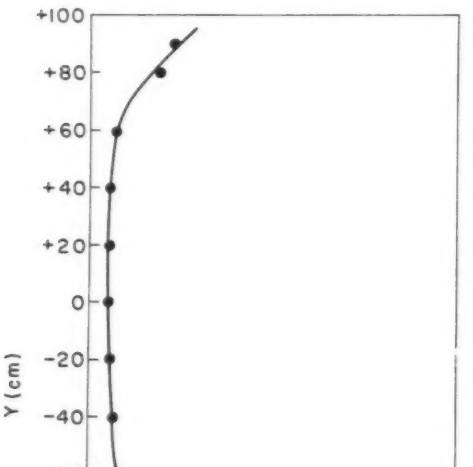

Fig. 12. Relative x-ray background for the symmetrical two-field treatment technic in the x = 0 plane. Measurements were made at a depth of 2.12 gm./sq. cm. of polystyrene.

tributions of the highly penetrating x-ray component to total-body radiation must be considered. The x-rays originate in a number of ways—from electrons striking disks in the accelerator tube, from the various components of the collimating and scattering system, from the intervening air, and finally from the tissue being treated. The tissue contribution is negligible. It is convenient to divide the sources of x-ray production in the collimator assembly (Fig. 3) into the axial sources, which interact with the central portion of the electron beam (window W, mirror M, external scatterer S_1, and diffuse air scatterer S_2), and the off-axis sources, which interact only with the peripheral electrons. Our experience indicates that the major source of x-ray background in the treatment plane is the group of axial sources.

From the scattering angle data of Table I and the collimator geometry of Figure 3, it may be seen that an appreciable fraction of the electrons are scattered so widely as to be intercepted by the lead collimators and jaws. Most of these electrons will be brought to rest in lead, where the ratio of radiative to collision energy loss is enhanced. Since at these energies the radiation is produced primarily in the forward direction, it is largely absorbed in the structure in which it is produced. No noticeable change was made in the x-ray background by lining the lead jaws and collimator with an absorber of low atomic number, thick enough to stop all the incident electrons.

It was found that the addition of collimator extension C_2 (Fig. 3) or an electron-restricting aperture between scatterer S_1 and the treatment plane does not influence the absolute x-ray intensity. If contributions from the more widely scattered electrons are not restricted, the dose uniformity in the treatment plane is improved, the average dose rate is raised, and the relative x-ray background is reduced.

The 0.5 per cent x-ray background is evidently directed in a narrow forward angle. A poor geometry experiment, with a thimble chamber, showed that this background had the characteristics of supervoltage x-radiation with a half-intensity thickness of about 13 cm. of unit density material. This radiation appears to originate almost entirely in the axial components listed in Table I. Examination of Table I shows that the x-ray background could be reduced by using a high-atomic-number material for scatterer S_1, since the decreased energy loss in S_1 would permit a lower energy for the incident electrons, with a consequent reduction in x-ray intensity. The x-rays along the axis are of the greatest intensity, and these depend markedly on electron energy (16).

Insertion of the mirror M and extension C_2 requires a higher-energy electron beam to duplicate the electron depth-dose dis-

tribution of Figure 7. The relative x-ray background is increased from 0.5 per cent to approximately 2.5 per cent. However, because the x-ray production occurs in a narrow forward angle, the 2-field geometry of Figure 1 places the highest part of the x-ray background outside the patient treatment area, as illustrated in Figure 12. In effect, the x-rays are directed largely over the head and below the feet.

SHIELDING AND EFFECTS OF OBLIQUE INCIDENCE

It is clear from the depth-dose curve of Figure 7 that adequate shielding will be provided by about 1.5 gm./cm.^{2} Since the electron range is nearly independent of atomic number, the shield can be of any convenient material. We have used 1 inch of fir plywood or 0.054-inch lead, about 1.5 gm./cm.^{2}; the latter appears to increase the relative x-ray background to slightly more than 0.5 per cent. In cases of treatment near the eyes, it has been convenient to fabricate slip-in contact eye shields of lead.

Under some circumstances a single treated body surface receives oblique contributions from two fields, *e.g.*, an anterior and a lateral field. It is then possible for a certain region of limited depth to receive a dose which approaches twice the maximum received from a single field at normal incidence. A method of partially solving the problem inherent in oblique incidence with fixed fields is to rotate the patient about a vertical axis during treatment. Certain areas would still present a problem, *e.g.*, the inside surface of the legs. The dosimetric complications which result do not appear to justify this approach. A limited number of patients have undergone therapy in which only the anterior and posterior aspects were treated.

ACKNOWLEDGMENTS: It is a pleasure to acknowledge the contributions of V. A. Prosper and P. A. Huisman, who were responsible for the construction of most of the components. Their skill and imagination have, in both design and fabrication, been invaluable.

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(Pro le summario in interlingua, vider le pagina sequente)

SUMMARIO IN INTERLINGUA

Un Technica pro le Electronotherapia Superficial a Grande Campos

Es describite un technica que permitte le application de electronotherapia superficial a areas extense.

Le accelerator linear typo medical Stanford (con un maximo de energia electronic de circa 6 Mev) esseva modificate de maniera a render possibile un facile conversion ab le therapia a radios X ad le therapia a electrones e vice versa. Pro therapia a electrones, le fasce es lassate exir per le existente systema de collimation pro radios X e dispergite per medio de un folio de aluminio. Per le appropriate combination de duo tal campos, uniformitate de dosage intra ±5 pro cento in omne areas del integre grandor e largor del subjecto human es effectuate, durante que le radiation X de fundo remane notabilemente infra 1 pro cento. Le sequente aspectos del technica es discutite: Collimation, controlo, perdita de energia, dispersion, dosimetria, fundo de radiation X, e armatura.

EDITORIAL

The Place of Radiology in Medical Education[1]

It is particularly appropriate to discuss medical education with a group of radiologists, since the radiologist almost more than any other specialist must live up to his obligations under the Hippocratic Oath. "... and that by precept, lecture, and every other mode of instruction I will impart a knowledge of the art." Every physician is charged with the responsibility of being a teacher, but the radiologist even more so. Whether he be full-time or part-time teacher, or practitioner, he is deeply involved in the educational process. The obligation to teach while practicing should be felt—and I believe it is felt—by all the practitioners of this specialty, because it serves as such an ideal medium for the propagation of medical knowledge.

No one today will question the fact that radiology should occupy some position in the education of the medical student. Just what the student should be taught as to use of radiation is, however, still a matter of controversy. The teaching of undergraduate students in radiology, and especially in roentgen diagnosis, has undergone many metamorphoses in the past decades; the philosophy, the motivation, and the methods of teaching have undergone many changes. Furthermore, even today, the quantity of teaching and the specific technics are totally different from one medical school to another. In some schools, the amount of undergraduate teaching approaches zero; in others, it represents a sizable share of the curriculum. Likewise, in the numbers of radiological faculty, facilities, and interest in teaching, there is a wide variation. It is obvious that we have failed to agree upon our objectives.

What are our motivations, our basic objectives, in teaching radiology to undergraduate students? Primarily, we wish to produce good doctors. We wish to teach the student the maximum utilization of a tool destined to be an important part of his practice and, when properly used, of great benefit to his patients. I could epitomize this by saying the student should learn enough to be able to force the radiologist to back up his opinion.

A second objective is to build up the status of radiology as a specialty in the minds of the medical profession. To accomplish this, the teaching of the undergraduate student is of the first importance. In one way or another the radiologist must make himself the master of the teaching in his own field. The demonstration to the student of x-ray films by surgeons, internists, pediatricians, in fact anyone other than the radiologist—as seen even now in many institutions—serves to diminish the importance, the status of radiology among the medical specialties. It is significant that in those areas where the radiologist does little or no undergraduate teaching, the standing of radiology in the medical community is at its lowest level. It is the duty and obligation of every radiologist who has contact with the student to develop within the mind of that student, in his earliest formative period, the idea that radiology is practiced by radiologists.

Then there is a final motivating force which should affect every teacher of radiology; namely, that only through properly oriented undergraduate students can he hope to obtain the best material for his residency or graduate teaching program. I am confident that to insure the develop-

[1] A condensed version of the Holmes Lecture presented before the New England Roentgen Ray Society on May 15, 1959.

ment, the progress, nay even the survival of radiology as a specialty, it is incumbent upon radiologists to make close contact with the medical student, to give instruction in the undergraduate years to the practitioner of tomorrow.

What are the purposes to which instruction in radiology may be put? They may be specified as follows: (1) Roentgen examination may be used as a tool for teaching the basic sciences. (2) Roentgenology affords an excellent visual method for teaching and remembering general medical subjects. It may serve as a correlating mechanism for the various medical specialties, unifying for the student the variety of ideas with which he is confronted. (3) The importance of radiation for diagnosis and therapy can be instilled into the mind of the student. He must be taught its usefulness in his future career as a physician, its possibilities and its limitations, and, especially, the dangers inherent in the use of this powerful weapon. (4) The very special features of radiology: that is, the technics, methods of examination, the results of examination, and means of protection against radiation, may be demonstrated. Incidentally, the great need for specialization in the field can be emphasized.

No one would cavil at the use of the roentgen method as a tool for teaching purposes. In many respects, it seems the ideal medium for the dissemination of knowledge in the preclinical sciences. By its use, the teaching of anatomy, pathology, and physiology can both be accentuated and accelerated. Furthermore, it is an excellent medium for correlation between the basic sciences and the study of the patient himself. But we have failed to use this tool effectively. A survey of American medical schools is disappointing, as it indicates that the potential of this medium has not been approached—in many instances its use is minimal. It is understandably difficult to obtain hours for roentgenology in the crowded curriculum of the first year but, with stimulation and co-operation from the radiologist, much can be accomplished. The radiologist can best teach roentgen anatomy for he brings to the first-year student a clinical outlook which is refreshing and stimulating. One method of doing this is to utilize the radiology residents for short periods of time as teaching assistants in the Department of Anatomy. Through this teaching experience, the resident gains enormously in his knowledge of normal anatomy, certainly basic to his training in roentgen diagnosis. At the same time, the student not only learns more of gross anatomy but develops a basic groundwork in normal roentgen anatomy, most useful for later teaching purposes.

Similarly, in the study of pathology, roentgen demonstrations are of the first importance. The gross pathology exhibited on the roentgenogram may be far superior in many instances to that which the pathologist can demonstrate from his specimens. Furthermore, the co-operation of the radiologist and the pathologist in the conduct of autopsy and surgical pathology conferences may lead to most illuminating and forceful teaching procedures for the undergraduate student.

In the field of physiology, intelligent interpretation of roentgenographic and fluoroscopic findings, especially if assisted by the use of motion pictures or television, can bring home vividly much information about the functioning of the circulation, of the lungs, and of the gastrointestinal tract.

I would emphasize that in all such teaching activities, the resources of the department of radiology, especially its resident staff, should be used to their fullest extent. In medical schools generally, the resident, who used to be called the "teaching fellow," is no longer given sufficient educational responsibilities.

It is when we reach the clinical years that the differences of opinion as to how much or how little should be taught become apparent. Much the same controversy exists with regard to the postgraduate teaching of radiology to practicing physicians. One might summarize the concepts of what and how much to teach in the clinical years as follows:

1. The student should be taught only

that radiology exists, has a certain usefulness in diagnosis and therapy, and is a field for specialization. The theory behind such a concept is that radiology is a highly specialized discipline, a subject intended only for graduate study. An effort to teach more to medical students or general practitioners can result only in turning out half-baked specialists, encouraging incompetent and dangerously unskilled application of a potent weapon. Such thinking has long permeated radiological teaching; similar arguments are used in opposition to giving short courses to practicing physicians. Repeatedly, Alexander Pope's aphorism, "A little learning is a dangerous thing," is quoted to support this thesis, but the remaining three lines of the stanza are omitted. They read: "Drink deep or taste not the Pierian Springs; their shallow draughts intoxicate the brain and drinking largely sobers us again." Is it really possible to prevent the student from tasting the Pierian Springs of knowledge of radiology? Obviously not, for if the radiologist does not teach radiology to the undergraduate, other clinicians will. We should stimulate our students to drink a little deeper and taste enough so that they will understand not only the advantages of radiology, but its disadvantages, its limitations, its harmful effects.

Such misgivings as I have quoted are doubtless not without foundation. Yet they must be reconsidered. The time has come to face these problems squarely and to ask ourselves: Can too much education in any field of medicine really be harmful? Is it not true that the more a rational individual learns of a subject, the more he appreciates his own limitations? My own experience with students indicates that the majority of them will form a pattern for their practice of medicine depending not so much on what they are taught, but rather on the promptings of their own consciences and the circumstances which they encounter. If they should be situated in rural districts where radiologists are not available, they may find some practice of radiology imperative. Any teaching which will improve their diagnostic ability is all to the good. That some physician who might not have purchased an x-ray machine would be stimulated to do so by the small knowledge gained during his student years is a possibility. It is more probable, however, that the imprudent physician, with the easy conscience, will enter into whatever practice his fancy or his apparent necessity directs, regardless of his qualifications or the instruction he has received.

2. The second proposal is to teach the undergraduate student the indications for x-ray examination, its possibilities, its limitations, the dangers, and the value of the procedure. Any effort to teach technics, interpretation, or the details of roentgen diagnostic procedures would be avoided.

3. There is a third concept, which is to teach the student as much as possible within the time available, assuming that the more he learns about radiology, the more respect he will have for it and the more caution he will exercise in its use.

It is obvious that any course of study must adjust itself to the established curriculum. Since radiology, one of the youngest of the specialties, arrived late on the scene of medical teaching, it is often difficult to allocate the time necessary for its teaching. Yet adjustments must constantly be made to permit the student to become acquainted with the most recent advances in medical science; certainly, none is more important than radiology. The problem of assigning time for radiology in the crowded hours is not an easy one. Most medical schools have been derelict in the reforming of their curricula; there is great reluctance to make drastic changes. In the semi-antiquated state of a curriculum, radiology suffers severely. The vast differences in the emphasis given anatomy or physical diagnosis, for example, as compared to radiology are deplorable.

The failure to allot sufficient time to radiology cannot be attributed entirely to conservative deans and reluctant committees. It may be that the fault is not in our stars but in ourselves. There is a reluctance,

in many cases an inability, on the part of radiologists in some medical schools to fulfill their obligations to the student. Teaching assignments for the radiologist may be extremely onerous. If he were to participate in all the conferences, clinics, and other exercises in which radiology is important, he might be spending the major portion of his waking hours on this task alone. In the course of a personal effort to bring radiology into the forefront of the teaching exercises at our hospital, I soon found myself spending all my time going from one clinic to another, from one conference to another. Such a situation becomes impossible, if, in addition, the radiologist is expected to carry a reasonable clinical load and attempt to do some investigation. In many cases, he becomes frustrated and relinquishes the clinics and conferences first of all, whereupon one of his colleagues, another specialist, steps readily into the vacuum created; he exhibits the roentgenograms and details the roentgen findings himself. A vicious cycle is thus set up and the radiologist finds himself outside the teaching schedule. Time stands as a barrier—the time of the student—the time of the instructor.

The limitations which restrict x-ray departments are many. For years, they have been understaffed to a deplorable degree. In a field which has grown with such rapidity it is understandable that administrators have had difficulty in fulfilling departmental needs. Furthermore, the number of radiologists, especially those who are inclined to do teaching and investigation, have been too few to satisfy the increasing demands. The sorry spectacle of a radiologist in a teaching institution carrying a clinical load of a hundred cases a day, attempting to do some undergraduate, as well as graduate, teaching, and then doing investigation at night or Sunday afternoon, was not uncommon a decade ago. With the passage of time, the situation has corrected itself, but there is still a sad lack of understanding of the time necessary for the three divisions of the radiologist's work.

Radiologists themselves have been in part responsible for this unhappy situation. All of us have seen examples of the spectacular and dramatic achievements of certain radiologists who turn out an enormous amount of clinical work each day and, surprisingly enough, do it moderately well. To achieve such a result, they are compelled to concentrate their entire energies, all of their thinking processes, all their vitality in this direction. We may see, for example, a radiologist who has an unusually large clinical load isolate himself in a small cubicle with the doors locked against any interruption while he does his interpretation. Such a cloistered procedure may lead to more accurate diagnosis, but it completely nullifies the contribution of the radiologist as a teacher. It certainly has a deleterious effect upon the role of radiology in any group endeavor. It tends to exclude the radiologist from academic councils, fixing upon him the label of a hospital service employee.

The economic motives which throw large loads of work upon radiologists have been thoroughly discussed elsewhere. The custom of using the income from the x-ray department to subsidize other areas of the hospital has led to many abuses. By preventing adequate staffing, it has handicapped radiology departments in fulfilling their teaching obligations.

The dependence of the radiology department upon its hospital earnings for a teaching budget also has had a deleterious effect. It has been an easy way to find funds for teaching, but it has separated radiology, given it an inferior status. Radiology, a virtual novitiate among the academic disciplines, has had difficulty acquiring a school budget. It would be wise to insist that all our teaching staff be on the university payroll—psychologically this is an important factor in giving the department academic rather than service status.

One other factor which tends to militate against the best undergraduate teaching efforts of radiologists is the extensive graduate training program which has become such a large part of the activities of

most medical schools. In some the graduate students are almost as numerous as the undergraduates. The growth of radiology as a specialty has carried with it the need for training many physicians and, as in all divisions of medicine, the number of residencies has increased enormously. As a result, the demands made upon the time and energy of the teacher at the graduate level are abnormally heavy. Because of the close relationship between the preceptor and his graduate students, there is a natural tendency to neglect the medical student and concentrate efforts and time on the residency program. To carry on such graduate teaching activity and also teach undergraduate students effectively requires a tremendous increase in the size of the faculty, a program which has not yet been satisfactorily accomplished in most medical schools in this country.

We should improve the teaching of the medical student by a proper utilization of radiology as a tool for demonstration in the preclinical years. We should expose the student to the wide usefulness of radiation in the management of the patient. To accomplish such purposes we must make certain changes in our concepts and procedures:

1. The radiologist must accept wholeheartedly his obligation as a teacher. He must be willing to help the student obtain sufficient knowledge of radiology so that he can appreciate fully its usefulness, its limitations, its dangers.

2. Radiology departments in medical schools should be reorganized to provide the staff with medical school rather than hospital stipends.

3. Curricula must be revised to permit more time for roentgen demonstration and the teaching of radiology.

4. A sufficient staff should be provided to permit a reasonable clinical load, adequate undergraduate teaching in all years, and a high level of graduate instruction, with ample time remaining for research.

Such changes will permit radiology to make its full contribution to the creation of good doctors.

LEO G. RIGLER, M.D.

IN MEMORIAM

Photograph by Fabian Bachrach

SIMEON T. CANTRIL, M.D.

1908–1959

The death of Dr. Simeon T. Cantril in Seattle, Washington, on Sept. 10, 1959, from coronary thrombosis, is a loss to radiology and related fields in the United States that will not be repaired in our time.

Following his formal education at Dartmouth College and Medical School and at the Harvard Medical School, he served his internship in the Michael Reese Hospital in Chicago. It was here that he began what was to be a life's work in radiotherapy. He went from residency at the Michael Reese Tumor Clinic with Dr. Max Cutler to study with Dr. Henri Coutard at the Institut du Radium in Paris. This remarkably fertile association of clinicians was continued at the Chicago Tumor Institute when Dr. Coutard came to this country. In 1938, Dr. Cantril moved to Seattle, Washington.

to become Director of the Tumor Institute of the Swedish Hospital, a position that he held with distinction until his death.

The Seattle appointment offered unique advantages to a man dedicated to the clinical art. Here was a sympathetic hospital with a Board eager to perform a service to the Pacific Northwest in what was then a relatively new field. Here was a small institute, yet one diversely enough equipped to let the therapist, rather than a machine, define the treatment. Here was an environment paced somewhat more slowly than that of the big cities to which radiation clinics then tended to be limited. No individual could have utilized these characteristics to better advantage than did Dr. Cantril.

Dr. Cantril devoted twenty-one years to bringing this clinic to its present maturity. His memorial of this period consists of two things—first, the irreplaceable personal skill, care, and understanding that he gave to each and every patient; second, the perpetuation of some part of his personal method and clinical life through his senior professional associates, his residents, and, in fact, all who saw him at work.

Of these things, and of his other personal contributions to radiology through his outstanding monographs, culminating in his 1958 review of carcinoma of the larynx, his medical associates can speak more definitively. As a nonmedical associate of Dr. Cantril and his clinic, I shall speak to three points.

In the first place, Cantril, the man, was virtually indistinguishable from Dr. Cantril, the physician. In either role, his first thoughts were for an understanding of others, and his second for ways of helping them. His personal modesty and sincerity were such that he would go to great lengths to avoid recognition of his good deeds, just as he shunned acclaim in his professional life.

In the second place, he established an ideal relationship with the exponents of the physical sciences and of the biological sciences that support medical radiology. Too easily can one physician, looking at each patient as an individual, fail to utilize the underlying simplifications and understandings that come only from physics and the like. Yet too easily can another become bound to a book of physical rules to treat a lesion rather than a patient. Dr. Cantril's perception of the needed balance was outstanding.

In the third place, there was an interlude in his main career in which his services were brought to bear on the national welfare at a time of grave national need. In 1942, Dr. Cantril became associated with the atomic bomb project. In succession he served as Director of Clinical Medicine at the Metallurgical Laboratories, University of Chicago; Medical Director of Clinton Laboratories, Oak Ridge, Tennessee; and Assistant Medical Superintendent, Hanford Engineer Works, Richland, Washington. In each of these tasks, he played a vital part in developing sound bases for radiation protection in a field in which potential radiation hazards at first seemed overwhelming. Even more vital was his personal interaction with the nation's nuclear scientists. His obvious integrity and interest in others combined with his particular professional knowledge to provide communication between men of alien disciplines that led to a balanced understanding of radiation hazards.

At the close of the war period Dr. Cantril returned to Seattle but gave freely of his time through service on advisory committees to the Atomic Energy Commission, the National Research Council, the National Institutes of Health, and many other national bodies concerned with radiology, radiobiology, and nuclear medicine. In addition, he served as consultant to industrial atomic energy organizations, as an associate professor of radiology, University of Washington, and as advisor to innumerable Washington State and British Columbia groups.

His life of unselfish dedication will be long remembered by all who knew him. Those who could count him as personal guide, counselor, and friend will cherish the privilege of so close a contact with so fine a man.

H. M. PARKER

JAMES W. LEWIS, M.D.

1912–1959

In the death of James W. Lewis, in Colorado Springs, Dec. 14, 1959, there was lost to radiology a dedicated practitioner, who not only contributed to his own specialty but was also active in building up good public relations between the medical profession and the lay public.

James W. Lewis, better known to his friends as "Joe," was born Aug. 27, 1912, in Salida, Colo. He received his undergraduate education in the University of Colorado and was graduated from the Colorado Medical School in 1936. Probably few of his friends realize that in his undergraduate years he was honored by election to Phi Beta Kappa for, in spite of his friendly spirit, he was a modest man. Having completed his internship in the Evanston Memorial Hospital, a part of the teaching set-up of Northwestern University, Joe entered private practice in Little Rock, Ark. There he remained for three years, at the end of which time he returned to Evanston, where he served his residency in Radiology under the guidance of Dr. Earl R. Crowder.

Called to military service in 1942, Joe became radiologist for the 7th Evacuation Hospital, which was the University of Illinois Unit. He was in Africa, Italy, France, and Germany, and after three and a half years left the Army as Lieutenant Colonel

and Chief of the Department of Radiology. His military service completed, he returned to his native state, joining a number of other young men, most of them from Northwestern University, in the establishment of the Colorado Springs Medical Center. Not only did he operate the Radiological Department for this group in its formative days, but at the same time he assisted Dr. George Unfug in his radiological practice in Pueblo.

In the fall of 1946 both Joe and the writer of these notes entered the practice of radiology in Colorado Springs, and a close friendship grew up between them. As one looks back over the years, Joe's interests appear to have been legion. He was particularly interested in sports and was a popular member of a weekly panel on sports events during the winter television season. He was active in the Quarterback Club and was an ardent baseball fan, never missing a game when the Colorado Springs Skysox were playing in the community. Many an umpire has cause to remember him with mixed feelings. At the time of his death he was serving on the Board of Education for Colorado Springs.

Professionally he was attracted by the possibilities opened up by the development of the isotopes and was responsible for the formation of the first isotope laboratory in the State of Colorado. He was prominent in the organization of the Society of Nuclear Medicine and was returning from a meeting of that group in Chicago when he was fatally stricken.

Joe's friends within the medical profession and outside of its ranks were almost without number. Few who met him ever forgot the warm friendliness of his personality. He could always be counted upon in trying circumstances to break up the tension with a well timed comment in a lighter vein. He will be greatly missed not only in the profession to which he gave such devoted service but by a wide circle of friends in all walks of life.

In 1935, during his senior year in medical school, Joe married Coral Dalton, or, as her husband always called her, Glorie or Gloria. She survives him, with their two children, a daughter, Carol, now working for her master's degree, and a son, Jim, an undergraduate in the University of Colorado.

VERNON L. BOLTON, M.D.

ANNOUNCEMENTS AND BOOK REVIEWS

ATLANTA RADIOLOGICAL SOCIETY

Recently elected officers of the Atlanta (Georgia) Radiological Society are: President, James V. Rogers, M.D.; Vice-President, Charles M. Silverstein, M.D.; Secretary-Treasurer, Wilson T. Edenfield, M.D., 1026 Scott Circle, Decatur, Ga.

GREATER SAINT LOUIS SOCIETY OF RADIOLOGISTS

The Greater Saint Louis Society of Radiologists has elected officers for the coming year as follows: Charles J. Cherre, M.D., President; Hugh Harting, M.D., Vice-President; Armand E. Brodeur, M.D., 35 N. Central Ave., Clayton 5, Mo., Secretary-Treasurer.

KANSAS RADIOLOGICAL SOCIETY

At the recent annual meeting of the Kansas Radiological Society, all officers were re-elected. They are: President, James R. Stark, M.D., of Wichita; Vice-President, Roger K. Wallace, M.D., of Manhattan; Secretary-Treasurer, Lewis G. Allen, M.D., 807 Huron Bldg., Kansas City, Kans.

RADIOLOGICAL SOCIETY OF LOUISIANA

The Radiological Society of Louisiana recently elected the following officers: President, Meyer D. Teitelbaum, M.D., New Orleans; Vice-President, Agrippa G. Robert, M.D., Baton Rouge; Secretary-Treasurer, Robyn Hardy, M.D., 4324 Magnolia St., New Orleans 15.

ROCHESTER (N. Y.) ROENTGEN RAY SOCIETY

Newly elected officers of the Rochester Roentgen Ray Society are: Charles E. Sherwood, M.D., President, Theodore F. Van Zandt, M.D., Vice-President, Robert H. Greenlaw, M.D., 188 Irvington Road, Rochester 20, Secretary-Treasurer.

The Society meets on the last Monday of each month, September through May.

CANADIAN ASSOCIATION OF RADIOLOGISTS

At the twenty-third annual meeting of the Canadian Association of Radiologists held in Toronto, in January, the following officers were elected: President, A. E. Childe, M.D., Winnipeg, Man.; Vice-President, D. L. McRae, M.D., Mount Royal, Que.; Honorary Secretary-Treasurer, Robert G. Fraser, M.D., Montreal; Associate Honorary Secretary-Treasurer, Jean-Louis Leger, Montreal. The General Secretary is Miss G. A. Mollison, 1555 Summerhill Ave., Montreal 25, Quebec.

SOCIEDAD DE ROENTGENOLOGÍA Y MEDICINA NUCLEAR, CÓRDOBA

The Sociedad de Roentgenología y Medicina Nuclear de la Provincia de Córdoba, Calle Santa Rosa 447, Córdoba, Argentina, recently elected the following officers: President, Dr. Raúl Oscar Pereira Duarte; Vice-President, Dr. Jorge Lavisse; Secretary-General, Dr. Carlos A. Oulton; Secretary of the Proceedings, Dr. Horacio R. Dalvit; Treasurer, Dr. Roberto B. Córdoba; Assistant Treasurer, Dr. Omar E. Bornancini; Vocales titulares, Ingeniero Juan Carlos Cervi, Dr. Osvaldo P. Brocca, and Dr. Nélida Vanetta de Di Rienzo; Vocales suplentes, Dr. Edmundo Arias, Dr. Luis Torres Amuchástegui, and Dr. Lidio G. Mosca.

UNIVERSITY OF TEXAS COURSE ON DIAGNOSTIC AND THERAPEUTIC USES OF RADIOIODINE

The Department of Radiology of the University of Texas Southwestern Medical School, Dallas, is offering an intensive postgraduate course in The Diagnostic and Therapeutic Uses of Radioiodine, June 20–25, 1960. The faculty will be the staff of the Department of Radiology and the visiting lecturer will be Reginald A. Shipley, M.D., Chief of the Radioisotope Unit, U. S. Veterans Administration Hospital and Department of Medicine, Western Reserve University School of Medicine, Cleveland, Ohio. The course is intended to qualify the enrollee for Atomic Energy Commission licensure. Enrollment is limited to ten.

Additional information may be obtained from Frederick J. Bonte, M.D., Professor and Chairman, Department of Radiology, or John S. Chapman, M.D., Assistant Dean, University of Texas Southwestern Medical School, 5323 Harry Hines Blvd., Dallas, Texas.

UNIVERSITY OF CINCINNATI REFRESHER COURSE IN DIAGNOSTIC ROENTGENOLOGY

During the week beginning June 6, 1960, the University of Cincinnati will conduct its third annual Refresher Course in Diagnostic Roentgenology at the Cincinnati General Hospital. Instruction will be given exclusively by members of the Radiology Staff. Enrollment is limited to radiologists and radiology residents and tuition is $150.00. Further information and application forms may be obtained from Dr. Benjamin Felson, X-Ray Department, Cincinnati General Hospital, Cincinnati 29, Ohio.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as

recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

DIAGNOSIS AND TREATMENT OF DISEASES OF THE TRACHEA AND BRONCHI. By HERMAN J. MOERSCH, M.D., Section of Medicine, Mayo Clinic and Mayo Foundation, Rochester, Minn., AND HOWARD A. ANDERSEN, M.D., Section of Medicine, Mayo Clinic and Mayo Foundation, Rochester, Minn. Publication Number 389, American Lecture Series. A monograph of 108 pages, with 35 figures. Published by Charles C Thomas, Springfield, Ill., 1960. Price $4.25.

X-RAY TECHNOLOGY. By CHARLES A. JACOBI, B.Sc., R.T.(A.R.X.T.), M.T.(A.S.C.P.), Chairman, Medical X-Ray Technology, Oregon Technical Institute, Oretech Branch, Klamath Falls, Ore.; Chairman, Education Committee, Oregon Society of X-Ray Technicians; Chairman, Education Committee, Northwest Conference of X-Ray Technicians; formerly Chief X-Ray and Medical Technologist, Medical Services Division, Atomic Energy Commission, National Reactor Testing Station, Idaho Falls, Idaho, AND DONALD E. HAGEN, R.T.(A.R.X.T.), Technical Supervisor for C. Todd Jessell, M.D., and George R. Satterwhite, M.D., Radiologists, Portland, Ore.; formerly Instructor, Medical X-Ray Technology, Oregon Technical Institute, Oretech Branch, Klamath Falls, Ore. A volume of 454 pages, with 320 illustrations. Published by The C. V. Mosby Co., St. Louis, Mo., 2d ed., 1960. Price $10.00.

Book Reviews

A TEXT-BOOK OF X-RAY DIAGNOSIS BY BRITISH AUTHORS. In Four Volumes. VOLUME IV: THE BONES, JOINTS, AND SOFT TISSUES. Edited by S. COCHRANE SHANKS, C.B.E., M.D., F.R.C.P., F.F.R., Director, X-Ray Diagnostic Department, University College Hospital, London, AND PETER KERLEY, C.V.O., C.B.E., M.D., F.R.C.P., F.F.R., D.M.R.E., Director, X-Ray Department, Westminister Hospital; Radiologist, National Heart Hospital, London. A volume of 714 pages, with 735 illustrations. Published by W. B. Saunders Co., Philadelphia, Penna., 3d ed., 1959. Price $21.00.

The third edition of this standard text on x-ray diagnosis is little changed from the second edition. This, however, does not detract from its intrinsic value but rather emphasizes the completeness of the earlier presentation. Some of the newer concepts in metabolic bone disease could be more carefully discussed but, since this is a dynamic and changing field, there would be no guarantee that any but a traditional presentation would be germane in several years.

The subject is covered in an orderly fashion, beginning with a discussion of general anatomy and pathology, followed by chapters on congenital defects, trauma, inflammation, constitutional diseases, and finally tumors and cysts. The concluding chapters are concerned with soft-tissue abnormalities and foreign-body localization.

The radiographs are reproduced in the positive which detracts somewhat from the attractiveness of the book but not from their descriptive value. The reproductions in this edition do not seem as sharp or have as much contrast as in the previous edition.

A SHORT TEXTBOOK OF RADIOTHERAPY FOR TECHNICIANS AND STUDENTS. By J. WALTER, M.A., B.M. (Oxford), M.R.C.P. (Lond.), F.F.R., D.M.R.E. (Camb.), Clinical Teacher in Radiotherapy, University of Sheffield; Deputy Medical Director, Sheffield National Centre for Radiotherapy; Consultant Radiotherapist, United Sheffield Hospitals and Sheffield Regional Hospital Board, AND H. MILLER, M.A., Ph.D. (Camb.), F.Inst.P., Chief Physicist, Sheffield National Centre for Radiotherapy, Hon. Lecturer in Radiological Physics, University of Sheffield. A volume of 528 pages, with 303 figures. Published by Little, Brown & Co., Boston, Mass., 2d ed., 1959. Price $10.00.

The standard of training of the British therapy "radiographer" is known to be much higher than that in this country. This book, designed as a text for such students, makes this clear. In completeness and detail, it would serve admirably as an introductory text for residents in radiation therapy and for the advanced student in radiation therapy technic.

The work begins with several chapters on radiation physics, including the structure of matter, the physical properties of roentgen and gamma radiation and their sources, detection and measurement of radiation, and dose distribution of these radiations in tissue. Radiation hazards are discussed in another chapter. Approximately half of the book is taken up by this discussion of physics.

The section on physics is followed by chapters introductory to pathology of tumors, biological effects, and principles of treatment and dosage. Discussions of technics for the treatment of representative malignant and nonmalignant conditions with x-rays, radium, and radioactive isotopes conclude the book.

The quality of the text is good, descriptions are clear, and illustrations are profuse and excellent.

THE MEDIASTINUM. By TED F. LEIGH, M.D., Professor of Radiology, Emory University School of Medicine; Director of the Department of Radiology, Emory University Hospital; Member of the Section of Radiology, Emory University Clinic, Atlanta, Ga., AND H. STEPHEN WEENS,

M.D., Professor of Radiology and Chairman of the Department of Radiology, Emory University School of Medicine; Director of the Department of Radiology, Grady Memorial Hospital; Chief of the Section of Radiology, Emory University Clinic, Atlanta, Ga. A volume of 246 pages, with 290 figures. Published by Charles C Thomas, Springfield, Ill., 1959. Price $11.50.

This book brings together under one cover the roentgen features of the majority of lesions of the mediastinum. Classification and pathologic characteristics of mediastinal lesions are presented briefly. Differential diagnosis is not stressed, nor is treatment considered. The main emphasis, as would be expected from the authorship, is radiological.

The first two chapters are devoted to the anatomy of the mediastinum, with particular emphasis upon the mediastinal lymphatics, including lymphatic drainage from the lungs. Chapters follow on the common mediastinal lesions and diseases involving the various organ systems. Much of the value of the book is in the generous number of reproductions of roentgenograms which give visual illustration of the text.

The subject is well covered, with some limitations. Expansion of the chapter on mediastinitis and addition of a chapter on specific infections would enhance the value of the work.

THE LAW OF MEDICAL PRACTICE. By BURKE SHARTEL, Professor of Law, University of Michigan, AND MARCUS L. PLANT, Professor of Law, University of Michigan. A volume of 446 pages. Published by Charles C Thomas, Springfield, Ill., 1959. Price $12.50.

This book is designed to present to medical students and physicians essential information on the bearing of the law on professional activities. The authors have sought to point out the major legal problems which may be encountered in medical practice, with suggestions for their solution and the avoidance of legal pitfalls.

The chapter headings indicate the scope of the work: The Physician's Professional Services; Compensation for Medical Care; The Physician's Liability for Malpractice; Other Tort Liabilities Incident to Medical Practice; Licensure of Physicians and Other Practitioners of the Healing Arts; The Physician's Business Transactions and Relationships; The Physician's Public Duties and Liabilities; Operation of the Legal System: General View. Decisions and cases are cited liberally.

The subject matter, as may be seen, is broad and, while the average doctor may not be interested in reading the text in its entirety, there are many portions which will be of value in connection with particular problems. The book will be found a handy reference work in any medical library.

ATLAS OF ROENTGENOGRAPHIC POSITIONS. By VINITA MERRILL, while Educational Director, Picker X-ray Corporation. A two-volume work of 674 pages, with numerous illustrations. Published by The C. V. Mosby Company, St. Louis, Mo., 2d ed., 1959. Price $32.50.

In the decade following the original publication of this *Atlas of Roentgenographic Positioning*, many developments have taken place in the radiologic field. Chief among them is the introduction of numerous new opacifying agents for the study of body structures that were previously not easily demonstrated. While the basic positions described in the first edition of this work have in general proved adequate for these studies, a number of newer positions and some earlier ones not formerly included have been added in the present revision. Altogether more than 1,500 illustrations vividly portray positioning used in every examination employed in present-day radiological endeavor.

The author seeks to clarify and standardize a terminology that will exactly describe the methods employed in achieving the various positions.

The work is organized according to the part of the body being examined. For each examination there are given a full description of the position of the patient and of the part, the projection of the central ray, and the structures to be shown. An anatomical and physiological review precedes each description. Bibliographic notes are furnished for those desiring further material.

The two volumes of this work supply a complete, up-to-date guide book so organized as to supply expert help in readily available form for any radiographic procedure.

THE YEAR BOOK OF CANCER (1958–1959 YEAR BOOK SERIES). Compiled and edited by RANDOLPH LEE CLARK, JR., B.S., M.D., M.Sc. (Surgery), D.Sc.(Hon.), Houston, Texas, Director and Surgeon-in-Chief, The University of Texas M. D. Anderson Hospital and Tumor Institute; Professor of Surgery, The University of Texas Postgraduate School of Medicine; Clinical Professor of Surgery, Baylor University College of Medicine; Chairman, Committee on Cancer, American College of Surgeons, AND RUSSELL W. CUMLEY, B.A., M.A., Ph.D., Houston, Texas, Director of Publications, The University of Texas M.D. Anderson Hospital and Tumor Institute; Professor of Medical Journalism, The University of Texas Postgraduate School of Medicine; Executive Editor, Medical Arts Publishing Foundation. A volume of 570 pages, with 202 figures. Published by The Year Book Publishers, Inc., Chicago 11, Ill., 1959. Price $8.00.

The present *Year Book of Cancer* is the third of the series. Like its predecessors, it covers the

entire field of oncology. It has been produced through the efforts of 419 persons and represents 116 journals. From approximately 4,000 articles, the editors have selected for abstracting 298, which in their judgment are the best to have appeared during the year covered (1957–58). About one-third of the papers abstracted are from foreign journals, and therefore unavailable to many who will profit by the concise summaries in the *Year Book*.

The principal parts of the body are covered, and there are separate sections on Tumors of Children, Bone and Soft-Tissue Tumors, and Tumors of the Endocrine Glands, as well as on Pathology, Roentgenology, Physics, Biology, etc. The newer work on chemotherapy is discussed.

Most of the abstracts appear to be well done and are easily readable. Editorial comment is appended in many instances, which is to be commended. This carefully selected group of abstracts presents a wealth of information for the busy practitioner who is interested in oncology.

RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

Editor's Note: Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates.

RADIOLOGICAL SOCIETY OF NORTH AMERICA. *Secretary-Treasurer*, Donald S. Childs, M.D., 713 E. Genesee St., Syracuse 2, N. Y.

AMERICAN RADIUM SOCIETY. *Secretary*, George G. Stetson, M.D., Englewood Hospital, Englewood, N. J.

AMERICAN ROENTGEN RAY SOCIETY. *Secretary*, C. Allen Good, M.D., Mayo Clinic, Rochester, Minn.

AMERICAN COLLEGE OF RADIOLOGY. *Exec. Secretary*, William C. Stronach, 20 N. Wacker Dr., Chicago 6.

AMERICAN CLUB OF THERAPEUTIC RADIOLOGISTS. *Secretary*, Juan A. del Regato, M.D., 2200 North Cascade Ave., Colorado Springs, Colo.

ASSOCIATION OF UNIVERSITY RADIOLOGISTS. *Secretary-Treasurer*, Paul A. Riemenschneider, M.D., 736 Irving Ave., Syracuse 10, N. Y.

SECTION ON RADIOLOGY, A. M. A. *Secretary*, T. Leucutia, M.D., 10 Peterboro, Detroit 1, Mich.

SOCIETY OF NUCLEAR MEDICINE. *Secretary*, Robert W. Lackey, M.D., 452 Metropolitan Bldg., Denver 2, Colo.

Alabama

ALABAMA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Garland Wood, Jr., M.D., Medical College of Alabama, Birmingham 3.

Arizona

ARIZONA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. Lee Foster, M.D., 1313 N. Second St., Phoenix. Annual meeting with State Medical Association; interim meeting in December.

Arkansas

ARKANSAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. B. Scruggs, M.D., 1700 W. 13th St., Little Rock. Meets quarterly.

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY. *Secretary*, William H. Graham, M.D., 630 E. Santa Clara St., San Jose.

EAST BAY ROENTGEN SOCIETY. *Secretary*, Dan Tucker, M.D., 434 30th St., Oakland 9. Meets monthly, first Thursday, at Peralta Hospital.

LOS ANGELES RADIOLOGICAL SOCIETY. *Secretary*, Denis C. Adler, M.D., 2010 Wilshire Blvd., Los Angeles 57. Meets second Wednesday, September, November, March, April, and June, Los Angeles County Medical Association Building.

NORTHERN CALIFORNIA RADIOLOGICAL SOCIETY. *Secretary*, Rob H. Kirkpatrick, M.D., 1219 28th St., Sacramento 16. Meets last Monday of each month, September through June.

PACIFIC ROENTGEN SOCIETY. *Secretary*, L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually at time of California State Medical Association convention.

RADIOLOGICAL SOCIETY OF SOUTHERN CALIFORNIA. *Secretary*, Joseph F. Linsman, M.D., 436 N. Roxbury Dr., Beverly Hills.

REDWOOD EMPIRE RADIOLOGICAL SOCIETY. *Secretary*, Lee E. Titus, M.D., 164 W. Napa Street, Sonoma, Calif. Meets second Monday every other month.

SAN DIEGO RADIOLOGICAL SOCIETY. *Secretary*, Stanley A. Moore, M.D., 2466 First Ave., San Diego 1. Meets first Wednesday of each month.

SAN FRANCISCO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Merrell A. Sisson, M.D., 450 Sutter St., San Francisco 8. Meets quarterly, at Grison's Steak House.

SOUTH BAY RADIOLOGICAL SOCIETY. *Secretary*, Stanford B. Rossiter, M.D., 1111 University Dr., Menlo Park. Meets second Wednesday every month.

X-RAY STUDY CLUB OF SAN FRANCISCO. *Secretary*, John H. Heald, M.D., 450 Sutter St., San Francisco 8. Meets third Thursday at 7:30 P.M., Children's Hospital, September through June.

Colorado

COLORADO RADIOLOGICAL SOCIETY. *Secretary*, Bertram L. Pear, M.D., 3705 E. Colfax Ave., Denver 6. Meets monthly, third Friday, at Denver Athletic Club.

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary-Treasurer*, Ralph J. Littwin, M.D., Bristol Hospital, Bristol. Meets bimonthly, second Wednesday.

District of Columbia

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY. *Secretary-Treasurer*, William E. Sheely, M.D., 1746 K St., N.W., Washington 6. Meets third Wednesday, January, March, May, and October, 8:00 P.M., in Medical Society Library.

Florida

FLORIDA RADIOLOGICAL SOCIETY. *Secretary*, John P. Ferrell, M.D., 166 4th Ave., St. Petersburg.

FLORIDA WEST COAST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Joseph C. Rush, M.D., Mease Hospital, Dunedin. Meets quarterly at the Tampa Terrace Hotel.

GREATER MIAMI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Donald H. Altman, M.D., 2751 Coral

Way, Miami. Meets monthly, third Wednesday, 8:00 P.M., at Jackson Memorial Hospital.

NORTH FLORIDA RADIOLOGICAL SOCIETY. *Secretary*, Paul A. Mori, M.D., 800 Miami Road, Jacksonville 7. Meets quarterly, March, June, September, and December.

Georgia

ATLANTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Wilson T. Edenfield, M.D., 1026 Scott Circle, Decatur. Meets second Friday, September to May.

GEORGIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, George W. Brown, M.D., 317 S. 8th St., Griffin, Ga. Meets in November and at the annual meeting of the State Medical Association.

RICHMOND COUNTY RADIOLOGICAL SOCIETY. *Secretary*, Wm. F. Hamilton, Jr., M.D., University Hospital, Augusta. Meets first Thursday of each month.

Hawaii

RADIOLOGICAL SOCIETY OF HAWAII. *Secretary-Treasurer*, Louis L. Buzaid, M.D., The Queen's Hospital, Box 861, Honolulu. Meets third Monday of each month.

Idaho

IDAHO STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Charles R. McWilliams, M.D., Twin Falls.

Illinois

CHICAGO ROENTGEN SOCIETY. *Secretary-Treasurer*, George B. Cahill, M.D., 802 Burns Ave., Flossmoor, Ill. Meets at the Sheraton Hotel, second Thursday of October, November, January, February, March, and April at 8:00 P.M.

ILLINOIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, George A. Miller, M.D., Carle Hospital Clinic, Urbana. Spring and Fall meetings.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, William Meszaros, M.D., 1825 W. Harrison St., Chicago.

Indiana

INDIANA ROENTGEN SOCIETY. *Secretary-Treasurer*, David E. Wheeler, M.D., 1500 North Ritter, Indianapolis. Meets twice a year, first Sunday in May and during fall meeting of State Medical Association.

TRI-STATE RADIOLOGICAL SOCIETY (Southern Indiana, Northwestern Kentucky, Southeastern Illinois). *Secretary-Treasurer*, James R. Mathews, M.D., 118 S. E. First St., Evansville, Ind. Meets October, January, March, and May.

Iowa

IOWA RADIOLOGICAL SOCIETY. *Secretary*, James T. McMillan, M.D., 1104 Bankers Trust Bldg., Des Moines. Meets during annual session of State Medical Society, and in the Fall.

Kansas

KANSAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Lewis G. Allen, M.D., 807 Huron Bldg., Kansas City, Kans. Meets in the Spring with the State Medical Society and in the Winter on call.

Kentucky

KENTUCKY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Robert H. Akers, M.D., VA Hospital, Louisville 2. Meets monthly, second Friday, at Seelbach Hotel, Louisville.

Louisiana

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary*, Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets second Tuesday of each month.

RADIOLOGICAL SOCIETY OF LOUISIANA. *Secretary-Treasurer*, Robyn Hardy, M.D., 4324 Magnolia St., New Orleans 15.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary*, W. R. Harwell, M.D., 608 Travis St. Meets monthly September to May, third Wednesday.

Maine

MAINE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Edward C. Porter, M.D., Eastern Maine General Hospital, Bangor. Meets in June, October, December, and April.

Maryland

MARYLAND RADIOLOGICAL SOCIETY. *Secretary*, Albert B. Shackman, M.D., 705 Medical Arts Bldg., Baltimore 1.

Michigan

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary-Treasurer*, Kenneth L. Krabbenhoft, M.D., 3825 Brush, Detroit 1. Meets first Thursday, October to May, Wayne County Medical Society rooms.

UPPER PENINSULA RADIOLOGICAL SOCIETY. *Secretary*, Arthur Gonty, M.D., Menominee. Meets quarterly.

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Donald H. Peterson, M.D., 25 W. Fourth St., St. Paul 2. Meets Fall, Winter, and Spring.

Mississippi

MISSISSIPPI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Bernard T. Hickman, M.D., University of Mississippi Medical Center, Jackson. Meets monthly, on third Thursday, 6:00 P.M., at Hotel Edwards, Jackson.

Missouri

GREATER ST. LOUIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Armand E. Brodeur, M.D., 35 N. Central Ave., Clayton 5, Mo. Meets on fourth Wednesday, October to May.

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. *Secretary*, Gerhard W. Schottman, M.D., 4400 J. C. Nichols Pkwy., Kansas City, Mo. Meets fourth Friday of each month October through May.

Montana

MONTANA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. K. Boughn, M.D., 35—11th Ave., Helena. Meets annually.

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Ronald E. Waggener, M.D., Nebraska Methodist Hospital, Omaha. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

Nevada

NEVADA RADIOLOGICAL SOCIETY. *Corresponding Secretary*, Robert M. Taylor, M.D., 2020 W. Charleston Blvd., Las Vegas. Meets during annual session of State Medical Society.

New England

CONNECTICUT VALLEY RADIOLOGIC SOCIETY. *Secretary-Treasurer*, Paul J. Kingston, M.D., 114 Woodland St., Hartford, Conn. Meets second Friday of October and April.

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary*, John E. Gary, M.D., 1180 Beacon St., Brookline 46, Mass. Meets third Friday, October through May, Longwood Towers, Brookline, Mass.

New Hampshire

NEW HAMPSHIRE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Paul Y. Hasserjian, M.D., 1470 Elm St., Manchester. Meets three times a year.

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary*, Austin J. Tidaback, M.D., 912 Prospect Ave., Plainfield. Annual meeting in Spring, Atlantic City; Fall meeting October or November, Newark.

New York

BROOKLYN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Isadore Katz, M.D., 450 Clarkson Ave., Brooklyn 3. Meets first Thursday of each month, October through May.

BUFFALO RADIOLOGICAL SOCIETY. *Secretary*, Alfred H. Dobrak, M.D., Sisters of Charity Hospital, Buffalo 14. Meets second Monday, October to May.

CENTRAL NEW YORK RADIOLOGICAL SOCIETY. *Secretary*, Joseph A. Head, M.D., Hospital of the Good Shepherd, Syracuse University, Syracuse. Meets first Monday, October through May.

KINGS COUNTY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, C. P. Naidorf, M.D., 411 Parkside Ave., Brooklyn 26. Meets fourth Thursday, October to April (except December), at 9:00 P.M., Kings County Medical Bldg.

NASSAU RADIOLOGICAL SOCIETY. *Secretary*, Jerome Zwanger, M.D., 126 Hicksville Road, Massapequa. Meets second Tuesday, February, April, June, October, and December.

NEW YORK ROENTGEN SOCIETY. *Secretary*, William B. Seaman, M.D., 622 W. 168th St., New York 32, N. Y.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Irving Van Woert, Jr., M.D., Albany Hospital, Albany. Meets in the capital area second Wednesday, October, November, March, and April; annual meeting, May or June.

RADIOLOGICAL SOCIETY OF STATE OF NEW YORK. *Secretary-Treasurer*, Mario C. Gian, M.D., 610 Niagara St., Buffalo 1. Meets annually with the State Medical Society.

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary-Treasurer*, Robert H. Greenlaw, M.D., 188 Irvington Road, Rochester 20. Meets last Monday of each month, September through May.

WESTCHESTER RADIOLOGICAL SOCIETY. *Secretary*, James C. Monteith, M.D., 170 Maple Ave., White Plains. Meets third Tuesday of January and October and as announced.

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary-Treasurer*, Owen Doyle, M.D., 1015 Professional Village, Greensboro. Meets in spring and fall of each year.

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary*, Richard F. Raasch, M.D., P.O. Box 990, Dickinson. Meets in the Spring with State Medical Association; in Fall or Winter on call.

Ohio

OHIO STATE RADIOLOGICAL SOCIETY. *Secretary*, Paul D. Meyer, M.D., 125 S. Grant Ave., Columbus. Society convention, Toledo, May 20–22, 1960.

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, William B. Schwartz, M.D., 1500 W. Third Ave., Columbus 12. Meets second Thursday, October, November, January, March, and May, 6:30 P.M., Fort Hayes Hotel, Columbus.

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Norman E. Berman, M.D., 14404 S. Park Blvd., Shaker Heights 20. Meets at 7:00 P.M., fourth Monday, October, November, January, February, March, and April, at Tudor Arms Hotel.

GREATER CINCINNATI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Stanley J. Lucas, M.D., Provident Bank Bldg., Cincinnati 2. Meets first Monday, September through May, at Cincinnati General Hospital.

MIAMI VALLEY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, G. F. Johnson, M.D., 1030 Reibold Bldg., Dayton 2, Ohio. Meets monthly, second Thursday, Miami Valley Hospital, Dayton.

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary*, J. Murphree, M.D., 617 E. Brookfield, Ponca City.

Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Barbara J. Radmore, M.D., 1162 Willamette St., Eugene. Meets monthly, second Wednesday, October to June, at 8:00 P.M., University Club, Portland.

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Arch Colbrunn, Jr., M.D., 164 W. Tanager St., Roseburg, Ore. Next annual meeting in Vancouver, B. C., in May 1960.

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Walter P. Bitner, M.D., 234 State St., Harrisburg. Next annual meeting, May 14–15, 1960, Pocono Manor.

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary*, Robert B. Funch, M.D., Germantown Hospital, Philadelphia 44. Meets first Thursday of each month at 5:00 P.M., from October to May, in Thompson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY. *Secretary*, Charles N. Chasler, M.D., Elizabeth Steel Magee Hospital, Pittsburgh 13. Meets monthly, second Wednesday, October through June.

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John H. Freed, M.D., 4200 E. Ninth Ave., Denver 20, Colo. Next annual meeting, Aug. 11–13, 1960, Denver Hilton Hotel, Denver.

South Carolina

SOUTH CAROLINA RADIOLOGICAL SOCIETY. *Secretary*, Wayne Reeser, M.D., 1600 Ninth Ave., Conway. Meets with State Medical Association in May.

South Dakota

RADIOLOGICAL SOCIETY OF SOUTH DAKOTA. *Secretary-Treasurer*, Donald J. Peik, M.D., 303 S. Minnesota Ave., Sioux Falls. Meets during annual meeting of State Medical Society.

The Southeast

Southern Radiological Conference. *Secretary-Treasurer*, Marshall Eskridge, M.D., 1252 Springhill Ave., Mobile, Ala.

The Southwest

SOUTHWESTERN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Gordon L. Black, M.D., 1501 Arizona Bldg., El Paso, Texas.

Tennessee

EAST TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Marsh Frere, Jr., M.D., 205 Medical Arts Bldg., Knoxville. Meets in September and January, and prior to State Medical Association meeting.

MEMPHIS ROENTGEN SOCIETY. *Secretary-Treasurer*, Hollis H. Halford, M.D., Kennedy VA Hospital, Memphis 15. Meets monthly first Monday, John Gaston Hospital.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James J. Range, M.D., P.O. Box 324, Johnson City. Meets annually with State Medical Association in April.

Texas

CENTRAL TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Glenn Addison Stokdyk, M.D., VA Center, Temple. Meets monthly, fourth Monday, at Kosel's Cafe, Temple.

DALLAS-FORT WORTH RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. H. Neil, M.D., 1217 W. Cannon St., Fort Worth. Meets monthly, third Monday, 6:30 P.M., at the Greater Fort Worth International Airport.

HOUSTON RADIOLOGICAL SOCIETY. *Secretary*, Edward Singleton, M.D., 6621 Fannin St., Houston 25. Meets last Monday of each month at the Doctors' Club.

SAN ANTONIO-MILITARY RADIOLOGICAL SOCIETY. *Secretary*, Hugo F. Elmendorf, Jr., M.D., 730 Medical Arts Bldg., San Antonio 5, Texas. Meets at Fort Sam Houston Officers' Club, third Wednesday of each month, 6:30 P.M.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. P. O'Bannon, M.D., 1216 Pennsylvania Ave., Fort Worth 4. Next meeting in Fort Worth, Jan. 20–21, 1961.

Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Richard Y. Card, M.D., St. Mark's Hospital, Salt Lake City 3. Meets third Wednesday, January, March, May, September, November.

Vermont

VERMONT RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John R. Williams, 46 Nichols St., Rutland.

Virginia

VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, Frank A. Kearney, 2nd, M.D., 110 S. Curry St., Phoebus.

Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Wayne A. Chesledon, M.D., 306 Stimson Bldg., Seattle 1. Meets fourth Monday, September through April, at College Club, Seattle.

West Virginia

WEST VIRGINIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Karl J. Myers, M.D., Myers Clinic-Broaddus Hospital, Philippi. Meets with State Medical Society, and as arranged by Program Committee.

Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Joseph F. Wepfer, M.D., 5000 W. Chambers St., Milwaukee 10. Meets fourth Monday, October through May, at the University Club.

SECTION ON RADIOLOGY, STATE MEDICAL SOCIETY OF WISCONSIN. *Secretary*, Abraham Melamed, M.D., 425 E. Wisconsin Ave., Milwaukee 2. Meets in October with State Medical Society.

WISCONSIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Howard G. Bayley, M.D., 124 Winn Terrace, Beaver Dam.

Puerto Rico

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA. *Secretary-Treasurer*, Dr. R. B. Díaz Bonnet, Suite 504, Professional Bldg., Santurce, P.R.

CANADA

CANADIAN ASSOCIATION OF RADIOLOGISTS. *Honorary Secretary-Treasurer*, Robert G. Fraser, M.D.; *Associate Honorary Secretary-Treasurer*, Jean-Louis Leger, M.D. *Central Office*, 1555 Summerhill Ave., Montreal 25, Quebec. Meets in January and June.

LA SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTRO-RADIOLOGIE MÉDICALES. *General Secretary*, Louis Ivan Vallée, M.D., Hôpital Saint-Luc, 1058 rue St-Denis, Montreal 18. Meets third Saturday of each month.

L'ASSOCIATION DES RADIOLOGISTS DE LA PROVINCE DE QUÉBEC. ASSOCIATION OF RADIOLOGISTS OF THE PROVINCE OF QUEBEC. *Secretary*, O. Raymond, M.D., 5400 Blvd. Gouin W., Montreal 9. Meets four times a year.

MONTREAL RADIOLOGICAL STUDY CLUB. *Secretary-Treasurer*, Fleming McConnell, M.D., 1650 Cedar Ave., Montreal, Que. Meets first Tuesday evening, October to April.

TORONTO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, L. R. Harnick, M.D., X-Ray Department, Toronto Western Hospital, 399 Bathurst St. Meets second Monday evening, September to May.

CUBA

SOCIEDAD CUBANA DE RADIOLOGÍA Y FISIOTERAPIA. *Secretary*, Dr. Miguel A. García Plasencia, Hospital Curie, 29 y F, Vedado, Havana. Meets monthly.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGÍA. *Headquarters*, Calle de Coahuila, Núm. 35, Mexico 7, D. F. *Secretary General*, Dr. Jorge Ceballos Labat. Meets first Monday of each month.

PANAMA

SOCIEDAD RADIOLÓGICA PANAMEÑA. *Secretary-Editor*, Luis Arrieta Sánchez, M.D., Apartado No. 86, Panama, R. de P.

ABSTRACTS OF CURRENT LITERATURE

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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Dynamic Encephalography. Eduardo C. Palma. Am. J. Roentgenol. **81:** 992–1000, June 1959. (Mercedes 937-Piso 2, Montevideo, Uruguay)

Since 1948 the author has used cisternal pneumoencephalography even in cases of increased intracranial pressure. Cisternal puncture offers two advantages. First, it allows an exact measurement of the pressure in the posterior fossa. Secondly, the size of the cisterna magna is established by the advancing needle before the final procedure is undertaken. It is sufficient to know that the measurement from front to back is at least 0.5 cm.

With the patient in a sitting position, firmly held with his head against a roentgenographic plate, an upward puncture is performed. The pressure is measured, 8 to 20 c.c. of oxygen is then injected rapidly through the needle, and films are obtained. The syringe is removed promptly but the needle is left in position to allow an immediate escape of injected oxygen or fluid to relieve the increased intracranial pressure that has been produced. The injection is repeated to obtain film studies in various projections, and finally the usual roentgenograms are taken to demonstrate the various parts of the lateral ventricles.

So far, 170 patients have been examined in this fashion. One fatal accident occurred in a comatose woman with multiple metastases. Minor complications such as headache, tachycardia, nausea, and vomiting have been observed.

The author has designated his technic "dynamic encephalography" because the roentgenograms are taken while the injected oxygen is moving upward through the ventricular system and also because the cerebrospinal fluid and gas are immediately allowed to flow out. The procedure shows the lateral and midline ventricular system quite clearly. It is generally well tolerated and causes fewer complications than encephalography *via* lumbar puncture. It must, however, be carried out only by experienced individuals, as any error is potentially hazardous.

Four roentgenograms: 14 diagrams.

JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

Pantopaque Ventriculography in the Localization of Surgical Lesions of the Posterior Fossa. Bruce L. Ralston, Sidney W. Gross, and Charles W. Newman. Am. J. Roentgenol. **81:** 972–983, June 1959. (Mount Sinai Hospital, New York 29, N. Y.)

Conventional pneumoencephalography and pneumoventriculography, as well as vertebral angiography, are generally inadequate for localization and diagnosis of posterior fossa lesions because of the poor visualization of the aqueduct and the third and fourth ventricles. The introduction of a contrast medium directly into the ventricular system has been reported, but the use of Lipiodol and Thorotrast for this purpose is questionable. Pantopaque, however, seems to be open to no objections. It has been used for ventriculography at the Mount Sinai Hospital (New York) for two years. The fourth ventricle has been visualized in almost every instance and the only side-effect has been an occasional transient meningeal reaction similar to that with air.

Briefly the technic is as follows: Three cubic centimeters of Pantopaque is instilled through burr holes into the lateral ventricle and pooled in the frontal horn with the patient prone. It is then made to pass through the foramen of Monro into the third ventricle by extension of the head. The patient is next turned onto the back and the medium is allowed to run into the fourth ventricle. Fluoroscopy is not necessary. Three films are taken initially: one in the Waters' projection, a 30° Towne, and one in a lateral position across the table. Oblique views may occasionally be of additional value. Also, if necessary, right and left lateral films, with the respective sides down, may be taken to visualize separately each side of the fourth ventricle. Usually 30 to 40 c.c. of air is injected to demonstrate the lateral ventricles. This may reveal possible elevation of the tentorium. On assumption of an erect position, the Pantopaque runs into the lumbar area and may be withdrawn through a needle. It will pass through very narrow places, even through blocks that are thought to be complete.

In 30 cases the authors successfully demonstrated posterior fossa lesions by this technic. In 1 case, a recurrent hemangioblastoma, the fourth ventricle could not be visualized. Obstructing and expanding lesions could be differentiated.

In general, the Pantopaque technic should follow fractional pneumoencephalography with 10 to 15 c.c. of gas. In persons not harboring a surgical lesion the fourth ventricle and cisternae will be filled by this procedure, thereby obviating the need for burr holes and ventricular tap. In those cases of "pseudotumor cerebri" which are clinically indistinguishable from a posterior fossa tumor, the attenuated ventricles will usually fill, not only avoiding an unnecessary ventriculogram but also the trauma occasioned by trying to tap very small ventricles. The procedure will also serve to disclose clinically mislocalized supratentorial masses and, in cases of aqueductal occlusion, a normal fourth ventricle with block of the aqueduct. In a few cases, adequate amounts of air will enter the ventricular system and permit an exact localizing diagnosis.

Nine roentgenograms; 10 drawings.

PAUL MASSIK, M.D.
Quincy, Mass.

Cisternal Pneumoencephalography. Sean Mullan and Anselmo Pineda. Am. J. Roentgenol. **81:** 984–991, June 1959. (University of Chicago Clinics, Chicago 37, Ill.)

After performing 118 pneumographies (46 by the lumbar route and 72 by the cisternal approach) in a variety of neurologic disorders, the authors are of the opinion that cisternal pneumoencephalography is the pneumography of choice in cases of suspect intracranial tumor without papilledema. It may also prove to be the procedure of choice with papilledema. It is less painful than lumbar pneumoencephalography. It is probably less dangerous. It is quicker than ventriculography. It does, however, possess the potential hazard of cord or medullary puncture in the hands of the inexpert.

The patient reclines on a chair, thrown well back, and flexes his neck. Reid's base line then lies horizontally and it is possible to direct the needle upward instead of straight in. In this fashion, if the needle is

inserted too far, it would continue upward into the cistern rather than through the spinal cord. The site of puncture is at the level of the mastoid tip, above the spinous process of the axis. The direction is toward the glabella. After local anesthesia, a No. 22 needle is advanced until it engages the thick drum-like atlanto-occipital membrane. It is then advanced 1 mm. beyond the membrane. If intracranial pressure is not increased, fluid will not flow freely. *If at the depth of 2 mm. no fluid is obtained, then one obeys the absolute unyielding law of cisternal puncture: in the presence of any problem or difficulty, desist.*

No pain is experienced during the injection of the first 10 c.c. of air. If pain occurs, air is not entering the ventricles and the head must be re-positioned. In ordinary cases 20 or 25 c.c. is adequate for a satisfactory air study. Injection is usually continued for three to five minutes, until some headache is manifest.

Five roentgenograms; 3 diagrams; 2 tables.

JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

Oblique Views: Their Place in the Arteriographic Diagnosis of Intracranial Aneurysms. J. S. Boyd-Wilson. J. Neurosurg. **16:** 297–310, May 1959. (Wellington Hospital, Wellington, New Zealand)

The author discusses the value of oblique views for the arteriographic diagnosis of cerebral aneurysms. The oblique view plays an important part in the demonstration of these aneurysms, supplementing lateral and anteroposterior projections; it is, however, no substitute for these. There is no theoretical basis for the claim that oblique views will disclose aneurysms not already revealed by proper lateral and anteroposterior projections: such reports are stated to be based on faulty technic. A large number of anteroposterior views are possible, but only one is suitable for the investigation of cases of subarachnoid hemorrhage; this projection is one in which the tube is angled so that the roof of the orbit and the petrous bones are superimposed, the internal carotid bifurcation is projected to its highest point above the base of the skull, and the proximal segments of both the anterior and middle cerebral arteries are unobscured.

The proper place of oblique views lies in demonstrating to better advantage aneurysms already disclosed by the preliminary lateral and anteroposterior radiographs. The relative merits of the available oblique views are discussed and those most useful for aneurysms in the four classical sites are described. At the internal carotid bifurcation, the most useful oblique view is the one in which the bifurcation of the internal carotid artery is projected into the center of the orbit. The correct projection is obtained when the patient's head is rotated 20° toward the normal side and the tube is angled 25° to the head from the orbitomeatal line.

For aneurysms of the anterior communicating artery and those at the junction with either anterior cerebral artery, the oblique half-axial view is optimum. The correct projection is obtained by rotating the patient's head 25° away from the side of the injection and centering 3 cm. above the mid-point of the uppermost supra-orbital margin. The tubes should be angled so that the central ray is parallel to a line drawn from the external auditory meatus to the supra-orbital margin on the side injected.

For aneurysms of the posterior communicating artery, a lateral projection is optimum, but oblique views are occasionally required in atypical cases. The one with the internal carotid bifurcation projected into the orbit is the most useful.

For aneurysms of the middle cerebral artery, an oblique view in which the middle cerebral bifurcation is projected into the center of the orbit is more satisfactory than the oblique half-axial projection.

Seven roentgenograms; 1 photograph; 1 drawing.

THEODORE E. KEATS, M.D.
University of Missouri

Infundibular Widening of the Posterior Communicating Artery Studied by Carotid Angiography. Georg-Fredrik Saltzman. Acta radiol. **51:** 415–421, June 1959. (Serafimerlasarettet, Stockholm, Sweden)

The posterior communicating artery is said to fill in one-fifth to one-third of all carotid angiographies, in which case the vessel often appears funnel-shaped at the site where it leaves the carotid siphon. This funnel-shaped part is called the infundibulum. It may be seen as a bulge-like opacification in cases without visualization of the posterior cerebral artery.

This proximal dilatation was identified in 67 of 1,020 carotid arteriograms of normal subjects, an incidence of about 6.5 per cent. A like percentage was found among patients with intracranial expansive processes and in a series of arterial aneurysms in the carotid region. The figure corresponded to 10 per cent of those studies in which visualization of the posterior cerebral artery was not obtained.

Preliminary histologic studies from autopsy material in patients with this proximal widening suggest changes similar to those seen in arterial aneurysm. In general the incidence increases with age.

Eighteen roentgenograms; 1 graph.

LAURENCE B. LEINBACH, M.D.
Bowman Gray School of Medicine

Midline Sagittal Pneumostratigraphy of the Vermis Cerebelli. Technic, Normal and Pathological Radio-Anatomy. F. Thiébaut, A. Wackenheim, J. P. Walter, and C. Vrousos. J. de radiol. **40:** 385–391, June-July 1959. (In French) (Clinique neurologique, Strasbourg, France)

The lateral pneumogram of the region of the vermis cerebelli is difficult to interpret because of the heterogeneous opacity of the bones of the temporo-occipital region and the gaseous superimpositions from the cerebellar hemispheres. The authors describe a technic for pneumostratigraphic examination of the vermis affording precise information as to its anatomical status.

Observations were made on 20 normal cases, 8 cases of cerebral atrophy, 3 cases of atrophy of the cerebellum, and 2 cases of hypogenesis of the vermis.

A complete description of the normal radioanatomy of the structure is given, with the measurements of its component parts. This is followed by a radioanatomic study of the pathological cases.

Ten roentgenograms; 6 diagrams; 1 table.

RENÉ HOURI, M.D.
New York, N. Y.

Roentgenologic Principles of a New Stereotaxic Apparatus. David Fairman. Am. J. Roentgenol. **81:** 1001–1005, June 1959. (University of Virginia, Charlottesville, Va.)

The successful introduction of guided instruments in the brain depends primarily on the proper roentgen

localization of intracerebral reference points in relation to the zero position of the electrode or needle. It is essential to keep the median plane of the skull parallel to the roentgenographic film because only under these conditions are all structures in the midsagittal plane of the skull projected in a constant ratio to the film.

In the instrument described in this paper, the position is insured by use of a roentgenographic guide attached to the apparatus. For that purpose the stem of the guide is provided with a frontal and anterolateral posterior movement which permits correct position that is always parallel to the film.

The ideal stereotaxic apparatus should fulfill the three following minimum requirements: (1) The apparatus should be as light as possible and must be attached rigidly to the skull in such a way that the measurements can be duplicated in exactly the same position when necessary; (2) The electrode holder or needle must have the necessary movement in all three directions in space, including inclination in the sagittal as well as in the frontal plane, and simultaneously measure the corresponding angles; (3) There must be provisions to position the skull exactly and rigidly for roentgenographic examination so that the median sagittal plane of the skull or preferably the zero line is parallel to or perpendicular to the roentgenographic film.

The author has developed an apparatus consisting of a platform, expanding ring, and needle carrier mounted in protractors. This is fixed in a trephine hole and adjusted so that one plane is always parallel to the film.

After testing this stereotaxic apparatus in experimental skulls and in cadavers, he has used it in 30 patients with excellent results as far as precision is concerned.

Ten figures. JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

The Cerebellar Astrocytomas. A Report on 98 Verified Cases. Alexander Gol and Wylie McKissock. J. Neurosurg. **16:** 287–296, May 1959. (A. G., Baylor University Medical School, Houston, Texas)

The authors report a series of 98 astrocytomas of the cerebellum and the roof of the fourth ventricle.

Plain roentgenograms provided considerable information. In 76 per cent of the series there was evidence of increased intracranial pressure. This was deduced from diastasis of sutures, erosion of the clinoid processes, or an obviously hydrocephalic skull. Enlargement of the posterior fossa appeared to be variable. No easy way could be discovered to judge what exactly is a large fossa for a skull of any particular size. Thinning or definite enlargement of one side of the posterior fossa as compared with the other was present in only 9 per cent of the cases. This sign, together with pathologic calcification, permitted preoperative localization in 20 per cent of the cases. In reviewing the films in light of the operative findings, the figure could perhaps be increased to 31 per cent.

In 92 per cent of the cases, the lesion was shown successfully by ventriculography. In a further 5 per cent, sufficient information was obtained to locate the lesion in the posterior fossa. Thus, in only 3 per cent was the ventriculogram inconclusive. Myodil was used whenever information obtained from the air studies proved inadequate. When all the early ventriculographic reports are taken into account, the rate of success falls only to 95 per cent for the whole series.

When the degree of hydrocephalus was determined by measuring the ratio of the maximum width of the anterior horns of the lateral ventricles to the internal width of the skull, a correlation was found between ventricular dilatation and operative mortality. Patients with greater degrees of dilatation showed the highest mortality. It is suggested that mortality may by reduced by ventricular drainage.

THEODORE E. KEATS, M.D.
University of Missouri

The Diagnosis of Chronic Inflammatory Lesions of the Sphenoid Sinus. J. H. Maxwell and B. Jay Hill. Ann. Otol., Rhin. & Laryng. **68:** 411–452, June 1959. (University of Michigan Medical Center, Ann Arbor, Mich.)

The purpose of this paper is to emphasize the obscurity of chronic inflammatory lesions of the sphenoid and by case presentations to demonstrate the differential diagnostic procedures, particularly radiographic, which may be required prior to definitive surgical therapy.

It is generally conceded that the sphenoid sinus is the least accessible of all sinuses to injury and infection. A serious fulminating acute sphenoiditis is rather rare, as are such closed lesions as mucoceles or pyoceles. The symptomatology is vague and the diagnosis difficult.

Four groups of cases are reported. In Group I are 3 cases of relatively obscure isolated sphenoiditis with objective findings which should have permitted earlier diagnosis. In Group II are 3 cases of sphenoid mucocele. Two of these patients had normal findings relative to the nose, nasopharynx, eyes, and cranial nerves. One had an orbital apex syndrome or sphenoid fissure syndrome associated with an extensive mucocele involving all the ethmoids and the sphenoid on one side. In Group III are 2 cases of unusual inflammatory disease which were not clearly understood. Group IV consists of several cases of neoplastic disease invading the sphenoid sinus, presented in an effort to emphasize the importance of complete and careful history and examination and the necessity of highly critical evaluation of the radiographs.

The one important symptom noted in these cases was headache. Most frequently it was bifrontal and temporoparietal. Deep-seated pain behind the eyes was noted frequently. In the more severe suppurative processes in this series, pain was occipital.

In a case of isolated sphenoid suppuration, it is unusual to find evidence of disease on anterior rhinoscopy. If there is a wide olfactory fissure, a small middle turbinate, and a favorably deviated septum, pus may be seen in the region of the sphenoidal ostium providing there is an opportunity for drainage. Pus, granulation tissue, or mucosal edema, should be visualized in the spheno-ethmoidal recess.

The radiographic examination is of importance. Lateral submentovertical views in stereo must be evaluated carefully. Simple inflammatory lesions produce increased density in the sinus, and in some instances it is possible to see a fluid level. If sclerosis and evidence of proliferation of bone in the walls of the sinuses are demonstrated, chronic inflammatory change is almost certainly present. In no instance was sclerosis of bone noted around an expanding or infiltrating neoplasm in the sinuses. If destruction of bone is noted on the x-ray film, a wide variety of lesions in and about the sphenoid

must be considered in an effort to determine if the lesion is inflammatory or neoplastic and if the sphenoid sinus is the primary seat of the lesion. To be differentiated are suprasellar erosion, intrasellar erosion, parasellar erosion, and primary involvement of the sphenoid sinus or clivus. The possibility of invasion secondary to nasopharyngeal neoplasm must also be evaluated. In selected cases arteriograms and planigrams may be of diagnostic value.

Two points of significance are made in the authors' conclusions: (1) Low-grade chronic inflammatory diseases of the sphenoid may exist for years before producing symptoms of sufficient severity to prompt the patient to seek medical help. (2) Obscure cases of isolated sphenoid suppuration and cases of sphenoidal mucocele or pyocele will submit to preoperative diagnosis prior to the onset of an orbital apex syndrome, providing the history and examination are adequate.

Thirty-five roentgenograms.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

The Postoperative and Postreduction Occlusal Film. Value with Particular Reference to the Submucous Resection and Nasal Plastic Operation (Septorhinoplasty). David Bernstein. Arch. Otolaryng. **69:** 695–699, June 1959. (1342 51st St., Brooklyn 19, N. Y.)

The author has found the occlusal film a valuable aid not only in the diagnosis of nasal fractures but also in evaluating the pre- and postoperative status in the nasal plastic operation and submucous resection (septorhinoplasty). It efficiently demonstrates bony, cartilaginous, and septal changes.

Three representative cases are reported. These cases show that fractures parallel to the frontal process of the maxilla are best visualized in the usual lateral view. Information from the Waters' projection is limited unless changes involve the malar area, the zygomatic area, or the nasal accessory sinuses.

Ten roentgenograms.

The Roentgenologic Aspects of Tympanoplasty: An Otologist's Viewpoint. W. E. Compere, Jr. Am. J. Roentgenol. **81:** 956–963, June 1959. (Moore-White Medical Clinic, Los Angeles 57, Calif.)

The development of tympanic cavity reconstruction demands better films and better interpretation of the mastoid area. Success of the operation depends upon (1) eradication of infection, (2) normal eustachian tube function, and (3) maintenance of a skin graft closing the new tympanic cavity. Radiographs must give information concerning the extent and activity of disease in the attic and additus, since the less surgical exploration required, the better the blood supply at the site of the skin graft. The malleus and incus can often be demonstrated radiologically, and this is important when there is discontinuity of the ossicular chain. The conventional views (Law and Chamberlain-Towne) should be supplemented by Mayer's position or the Owen modification, Stenvers' and Schüller's projections.

The activity of the eustachian tubes in emptying the tympanic cavity may be determined by filling the middle ear with opaque material and taking a film in the Stenvers' position, followed by another in ten minutes. Normally the middle ear drains quickly and is almost empty by the time the second film is obtained. If drainage does not occur, exploration of the hypotympanum and tubal orifice becomes mandatory.

Thirteen roentgenograms; 3 diagrams.

PAUL MASSIK, M.D.
Quincy, Mass.

THE CHEST

The Role of Bronchography in the Diagnosis of Bronchogenic Carcinoma. Kenneth E. Wilt, Neil C. Andrews, Charles V. Meckstroth, William Molnar, and Karl P. Klassen. Dis. of Chest **35:** 517–523, May 1959. (Ohio State University Health Center, Columbus, Ohio)

In an attempt to differentiate bronchogenic carcinoma from other pulmonary lesions, bronchography was utilized in a total of 1,408 patients between January 1952 and December 1955. A clinical diagnosis of carcinoma was made in 259 of these, with histologic proof in 236.

If any evidence of a bronchial block could be demonstrated, repeated attempts were made to fill the involved bronchus with the contrast medium by changing the position of the patient, instructing him to inhale deeply, or by instillation of additional contrast material until the examiner was satisfied that an actual obstruction was present. Spot films of the area were taken, as were standard postero-anterior, oblique, and lateral views. When a bronchial block was believed secondary to retained mucus or blood, the examination was repeated at a later time. Severe hemoptysis prior to bronchography also necessitated temporary postponement. All patients with profuse or tenacious sputum were treated with postural drainage, bronchodilators, wetting agents, and antibiotics prior to examination.

Bronchography was without complications, with the exception of minor febrile reactions in a few patients receiving Dionosil as the contrast medium. Bronchoscopy was performed in most patients following bronchography, with utilization of the information gleaned from the previous procedure to facilitate localization of the lesion.

In 69 of the 236 cases of proved bronchogenic carcinoma, circumscribed masses were demonstrated in the lung fields, and in 80 per cent of these there was associated bronchial obstruction. Among 57 patients with infiltrative lesions resembling pneumonitis, bronchial block was present in 97 per cent. A block existed in all 56 patients with atelectasis and all 13 with pleural effusion (masking atelectasis and/or parenchymal disease). Seventy-five per cent of those with hilar or mediastinal masses showed obstruction.

The histologic cell type did not appear to bear any relation to the presence of bronchial block.

The main stem bronchus was involved in 22 per cent of this series, a lobar bronchus in 54 per cent and a segmental bronchus in 24 per cent. The resection rate was highest in those with segmental block and lowest in patients in whom the main bronchus was obstructed. Resectability of the pulmonary neoplasm was higher in patients with demonstrable bronchial block than in those without. Bronchoscopy was of greatest value, as might be expected, in establishing the histologic diagnosis in patients with main stem bronchial block.

Although bronchial obstruction is not definitely diagnostic of bronchogenic carcinoma, block in this condi-

tion is usually abrupt and complete (although it may be tapered in disease or large bronchi), as opposed to the distorted but still patent bronchial pattern of infectious disease. History, laboratory data, and other radiologic technics may help to establish the nonmalignant nature of a pulmonary lesion. In only 3 of the patients in this series with bronchographic evidence of carcinoma was the diagnosis not confirmed at operation.

Five tables. HENRY K. TAYLOR, M.D.
New York, N. Y.

Mass Radiography and Cancer of the Lung. E. Posner, L. A. McDowell, and K. W. Cross. Brit. M. J. 1: 1213–1218, May 9, 1959. (E. P., Stoke-on-Trent Mass Radiography Unit, Stoke on Trent, England)

Although statistical evidence points to the small chance of influencing the course of lung cancer, there is no unanimity of opinion as to whether a program of routine mass x-ray examination would produce significant improvement of prognosis by detecting early asymptomatic cases which could have the benefit of prompt treatment. The present article seeks to throw some light on this matter.

A routine survey program, carried out during the year 1956 with static and mobile units using 35-mm. film, yielded 54 cases of carcinoma of the lung among 173,610 supposedly asymptomatic persons in the Birmingham (England) region. The incidence, age of distribution, resectability, and survival rates are analyzed and compared to another group of 223 lung cancers found in that area during the same period among symptomatic patients referred for chest films by general practitioners. The case-finding rate was much higher for the referrals (8.7 per 1,000) than in the routine survey group (0.3 per 1,000). Follow-up was obtained for the majority of patients in both groups.

The resectability was higher in the cases discovered by routine survey (44 per cent) than among the referred symptomatic patients (36 per cent). A greater proportion of lobectomies was performed on the survey group, while pneumonectomy was the predominant type of resection for the general-practitioner referrals. However, the different selection of patients in different surgical centers makes difficult a true comparison of these rates. The two-year survival rate, irrespective of treatment, was 25 per cent for the survey cases and 20 per cent for the referrals. Among the resected cases, these rates were respectively 44 and 38 per cent.

Considering that further careful inquiries revealed only a small percentage (15 per cent) of the supposedly asymptomatic patients who could actually be so classified, the authors believe that it cannot be stated at present that routine mass radiography is a certain mean of detecting early cancer or yields a significant improvement of prognosis.

One graph; 10 tables. ANTONIO SIMAO, M.D.
Cleveland Metropolitan General Hospital

How Chronic Is Pulmonary Tuberculosis in the Elderly? James Smith. Brit. M. J. 1: 1448–1451, June 6, 1959. (Ruchill Hospital, Glasgow, Scotland)

Previous roentgenograms of 50 of 100 tuberculosis patients over fifty-five years of age were available for review. The first studies had been made within five years of diagnosis in 38 patients. In only 3 were they made before the age of fifty. In 23 instances the films had been said to be "clear"; abnormalities in the others were: inactive fibrotic tuberculosis (12 cases), unresolved pneumonia (7), bronchitic changes (4), miliary opacities (1), bronchiectasis (1), calcified foci (1), pleural effusion (1). In 2 of the films originally considered clear, apical fibrosis was noted on review; in 2 others small calcified foci were seen in an upper lobe. These appearances were minimal.

In 10 of the 12 cases of "inactive fibrotic tuberculosis," there was agreement on reassessment of the films. In 1 patient the possibility of activity might have been raised and in another a small area of fibrosis on the contralateral side had been overlooked.

Seven patients with pneumonia had been discharged from various hospitals before radiological resolution was complete. In 2, significant x-ray features had been overlooked: in 1 case the development in serial films of a small area of infiltration in the contralateral lung and in another the presence of a small pleural effusion.

A diagnosis of chronic bronchitis had been made in 4 cases, presumably because of increased lung markings associated with some fibrosis and emphysematous change.

The possibility of miliary tuberculosis was reported in 1 patient, but the occupational history and subsequent course confirmed the retrospective diagnosis of pneumoconiosis.

In 1 patient, left-lower-lobe bronchiectasis had been reported in two successive years, infiltration in both upper lobes being overlooked. A year later sputum examination revealed numerous tubercle bacilli.

The evidence suggested in 2 cases that the disease had developed in the same manner as a primary tuberculous lesion. Three additional patients had apparently contracted tuberculosis from a younger member of the household and 1 from his wife.

The author concludes that if there is any suspicion of tuberculosis in an older person, immediate roentgen studies are essential even though a recent film has been reported clear.

Two tables.

Positive Roentgenograms Plus Positive Sputum Smears Do Not Always Equal Pulmonary Tuberculosis. C. Allen Good, David T. Carr, and Lyle A. Weed. Am. J. Roentgenol. 81: 187–195, February 1959. (Mayo Clinic, Rochester, Minn.)

Seven case reports emphasize the fact that the radiographic diagnosis of tuberculosis is only presumptive and should be confirmed by specific identification of the micro-organism by means of its cultural characteristics and virulence for laboratory animals. The presence of acid-fast bacilli in a stained sputum smear does not necessarily confirm a roentgen impression of pulmonary tuberculosis.

The organisms producing roentgenographic appearances which closely resemble tuberculosis have not been specifically identified beyond classification according to their chromogenic activities. Some are photochromogens, which produce buff and cream-colored colonies in darkness and lemon-yellow colonies when grown in light. Others are nonphotochromogens, producing buff or cream-colored colonies wherever they are grown. Scotochromogens, seen only occasionally in association with pulmonary disease, produce yellow or orange colonies wherever grown. Most of the strains are resistant to isoniazid and para-aminosalicylic acid and are partially resistant to streptomycin. While

none of the three types produces generalized disease in guinea pigs, some are pathogenic for mice.

Nine roentgenograms.

RICHARD F. MCCLURE, M.D.
Redondo Beach, Calif.

The Changing Roentgenologic Picture in Pulmonary Tuberculosis Under Modern Chemotherapy. Richard M. Friedenberg, Norman Isaacs, and Milton Elkin. Am. J. Roentgenol. **81:** 196–206, February 1959. (Albert Einstein College of Medicine, Bronx, N. Y.)

As used today, specific chemotherapy may produce rapid and dramatic improvement in the roentgen picture of pulmonary tuberculosis. The shorter the interval between onset of disease and commencement of chemotherapy, the more consistent and complete is the resolution of the exudative lesion. When chemotherapy is used in a patient having exudative, fibrocaseous, and fibroproductive lesions, the exudative lesions usually resolve completely and the fibrotic lesions are limited to the parenchyma already involved. With chemotherapy, closure of as many as 85 per cent of single cavities has been reported, and 55 per cent of multiple cavities have disappeared. Isoniazid therapy often produces a sterile thin-walled cavity. When isoniazid is used in miliary tuberculosis, the lesions may disappear completely, and the survival rate may exceed 90 per cent. Following the ACTH, isoniazid and para-aminosalicylic acid, there may be steady improvement in tuberculous pleural effusions. The dramatic response of tuberculous pneumonia to chemotherapy is enhanced by the addition of ACTH.

Chemotherapy is primarily effective against fresh, exudative lesions. The irreversible anatomic changes of fibrosis and caseation are poor prognostic signs.

Nine case reports are included.

Twenty roentgenograms.

RICHARD F. MCCLURE, M.D.
Redondo Beach, Calif.

Staphylococcic Pneumonia. Shakeeb Ede, George M. Davis, and Francis H. Holmes. J.A.M.A. **170:** 638–643, June 6, 1959. (U. S. Naval Hospital, Great Lakes, Ill.)

The authors analyze 36 cases of staphylococcic pneumonia seen in a U. S. Naval Hospital over a three-year period. This represented about 1.5 per cent of all the acute pneumonias. One death occurred within seventy-two hours of the first symptoms. Thirty-four cases are classified as primary pneumonia, apparently incurred outside the hospital. Two were thought to be secondary, one following osteomyelitis, and the other secondary to a carbuncle on the neck. Each of these two patients had a positive blood culture. In none of the patients with primary pneumonia was the blood culture positive. Four cases may have been due to a "hospital organism," in that two infants were children of staff physicians; the mother of one patient worked in the hospital nursery and her throat culture showed coagulase-positive *Staph. aureus* in almost pure culture; 1 patient contracted the disease while under observation in a surgical ward. In these instances, the pneumonias were more severe, complications were more rapid, and the drug control more difficult than in the other cases.

Bacteriological proof is necessary to identify this disease clinically, but certain signs, symptoms, and findings should suggest its possibility. These include the presence of dyspnea out of proportion to the clinical findings of pneumonia; a dusky cyanosis of the lips and nail beds accompanying the dyspnea; normal roentgen findings or minimal changes for the first twenty-four to forty-eight hours, with subsequent demonstration of multiple lobe involvement or scattered pneumonic areas within both lung fields. In a toxic patient, there is pleural pain associated with rapid or progressive pleural effusion which does not respond to the usual antibiotics. The development of pyopneumothorax or a bronchopleural fistula during the course of acute pneumonia is virtually an assurance of staphylococcic origin. The occurrence of a pneumatocele is also highly suggestive of this entity.

Initially the chest film shows very little of significance in a patient who is quite toxic and in respiratory distress. Changes are rapid, and often a second film taken within twenty-four hours reveals rather extensive abnormality. The most common x-ray finding on admission was several small, roughly oval or rounded areas of consolidation, quite often bilateral. Change in appearance is again the rule, and clearing of many of the original foci may be observed. Concurrent with this clearing will be the appearance of new foci either in the same or hitherto uninvolved lobes. Infiltrates that persist will usually show cavity formation within ninety-six hours. After cavitation, any of six courses may develop: (1) spontaneous resolution of the cavity, (2) coalescing of small cavities to form large cavities, (3) evacuation of the fluid content and persistence of the cavity as a pneumatocele, (4) bronchopleural fistula formation, (5) empyema formation without bronchopleural fistula, (6) necrosis of the affected lung. The coalescing of small cavities is practically pathognomonic of straphylococcic pneumonia. A high incidence of complication is seen in this form of pneumonia. A close co-operation between the surgeon and internist is advocated for early surgical treatment when this is indicated.

Five roentgenograms; 1 diagram.

JOHN P. FOTOPOULOS, M.D.
Northwestern University Medical Center

Surgery of the Definable X-Ray Lesion in Apparently Healthy Military Personnel. Norman V. Cooley, Joseph M. Hanner, Edgar Ricen, and Ivan D. Baronofsky. Dis. of Chest **35:** 494–508, May 1959. (U. S. Naval Hospital, San Diego, Calif.)

During a two-year period, 1955 and 1956, at the U. S. Naval Hospital in San Diego, Calif., 102 major surgical procedures were performed for asymptomatic pulmonary lesions. These lesions were discovered during periodic physical examinations or in the course of hospitalization for unrelated illnesses. There were 89 granulomas, classified as nonspecific (48 cases), tuberculous (23 cases), coccidioidal (15 cases), histoplasmosis (2 cases), and lipoid (1 case). Other diagnoses (1 case each) included hamartoma, bronchial adenoma, chronic empyema, bronchogenic carcinoma, alveolar-cell carcinoma, sequestration, congenital cystic disease, pericardial cyst, exostosis from fractured rib, congenital absence of right pulmonary artery with hyperplasia of the lung.

The x-ray findings were for the most part described as a nodule, infiltrate, or cavity. A nodule was a more or less sharply circumscribed rounded shadow measuring less than 3.5 cm. and surrounded by healthy lung, while an infiltrate was an irregular parenchymal density with no clearly defined borders. Nodules were present

57 times, and infiltrates 33 times. Single cavities occurred in 6 cases and multiple cavities in 1. In 1 instance both a cavity and soft apical nodule were found, representing associated carcinoma and tuberculosis. In addition to the above, there was 1 case with thickened pleura and another with a smooth rounded density at the right cardiodiaphragmatic angle which proved to be a pericardial cyst. As mentioned above, there were also observed a sequestrated left lower lobe, multiple bullae with congenital cystic disease, and absence of the right pulmonary artery with atelectasis of the right upper lobe.

Of 39 calcified nodules, 27 proved to be nonspecific caseous granulomas; 9 coccidioidomycosis; 1 each histoplasmosis and tuberculosis. In 1 case no gross abnormality was found on exploration.

This collection of cases represents a relatively young age group, and the positive findings differ percentagewise from similar studies in civilian personnel.

Two roentgenograms; 5 tables.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Less Familiar Roentgen Patterns of Pulmonary Granulomas: Sarcoidosis, Histoplasmosis and Noninfectious Necrotizing Granulomatosis (Wegener's Syndrome). Benjamin Felson. Am. J. Roentgenol. **81:** 211-223, February 1959. (Cincinnati General Hospital, Cincinnati 29, Ohio)

Sarcoidosis is a well known disease showing lymphadenopathy, disseminated miliary densities, localized infiltrates, and fibrotic changes, alone or in combination, on the chest roentgenogram. Attention is directed to two less familiar x-ray patterns which have been observed in this condition: (*a*) a large multinodular pattern, with multiple round densities throughout both lungs, having hazy outlines and tending toward confluence; (*b*) a multicystic pattern, with the appearance of cystic lesions in gradually increasing numbers in an already extensive pulmonary infiltrate. This represents a late manifestation of the disease.

Histoplasmosis usually presents one of three pictures: (*a*) acute dissemination, with small patches of infiltration throughout the lungs, (*b*) a localized pneumonic form, and (*c*) the small solitary nodule. The healing phase of these types is characterized by deposition of calcium. The disease, however, sometimes assumes a fibrocavitary form with large cavities and slow progression to a fatal termination. Not all nodular histoplasmomas are inactive; 2 cases are reported in which the nodule, even though calcified, slowly enlarged until surgical resection became necessary to establish the true nature of the lesion. It is not unlikely that in endemic areas histoplasmosis may be associated with broncholithiasis, esophageal traction diverticula, large calcified nodular lesions in the lungs, and even a middle lobe syndrome or chronic superior vena caval obstruction.

Noninfectious necrotizing granulomatosis (Wegener's syndrome) produces a severe and striking destruction of the midline facial structures, ulcerations and granulomas of the paranasal sinuses, the mouth, and other portions of the upper respiratory tract. There may be pulmonary involvement with severe pain, cough, hemoptysis, and night sweats. Indolent skin ulcerations are seen. Chest radiography shows nonspecific changes, consisting in nodular or localized infiltrates as well as bronchopneumonia and edema. Cavitation and pleural effusions sometimes occur. The two basic pathological features of this disease are (*a*) the aseptic granulomas, and (*b*) the striking vascular lesions, namely, necrotizing inflammations of both arteries and veins. The differential diagnosis is broad and extensive, but when the roentgen pattern consists of multiple poorly defined nodules or infiltrates with central cavitation, consideration of this syndrome is warranted.

Seventeen roentgenograms.

RICHARD F. MCCLURE, M.D.
Redondo Beach, Calif.

Clinical and Roentgenologic Signs of Collagen Diseases Involving the Thorax. Charles M. Nice, Jr., A. N. K. Menon, and Leo G. Rigler. Dis. of Chest **35:** 634–649, June 1959. (Tulane University, New Orleans)

The collagen diseases represent a group of afflictions characterized by a systemic alteration of the connective tissues throughout the body. Clinical and pathologic features of these diseases are not always distinct and various syndromes may overlap. In the present report those conditions which involve thoracic structures are studied and five collagen disorders are considered. These are polyarteritis nodosa, disseminated lupus erythematosus, scleroderma, dermatomyositis, and rheumatic pneumonitis. One hundred and nine patients with these diseases were seen at the University of Minnesota Hospitals from 1942 to 1956. In two-thirds diagnosis was established by autopsy and biopsy and in the remainder there were strong clinical and laboratory data to support the diagnosis.

Detailed consideration is given to etiology, clinical and laboratory manifestations, pathology, and treatment of these disease states. Special attention is directed to the roentgenologic findings.

Roentgen signs should appear in the chest at some phase of the disease in about 80 per cent of patients. Interstitial pneumonitis, pleural effusion, and a nonspecific type of cardiac enlargement occur with sufficient frequency in all five diseases that they may be considered confirmatory in nature but not of differential value. Bilateral hilar vascular prominence, in the collagen group, is found most commonly in polyarteritis. Interstitial pulmonary fibrosis and emphysema are seen frequently with scleroderma and dermatomyositis. In 20 per cent of scleroderma cases there will be a diffuse honeycomb appearance in the lower two-thirds of the lungs.

Cardiac valvular lesions, pericarditis, and pleural effusion are more common in disseminated lupus and rheumatic pneumonitis. Small pulmonary nodules are seen more frequently in polyarteritis and scleroderma. Small areas of pulmonary consolidation suggesting infarcts may appear in polyarteritis.

Roentgen signs of these diseases may be observed less frequently in other organs. These include dilatation and lack of peristalsis of the esophagus, absorption of the terminal phalanges, calcification of soft tissues, and absorption of the periodontal membrane, all seen in scleroderma; calcification of subcutaneous tissues in dermatomyositis; partial obstruction or adynamic ileus in polyarteritis and scleroderma. Rheumatoid arthritis is frequently associated with polyarteritis, scleroderma, and dermatomyositis. Roentgen signs may regress under steroid therapy.

Twelve case reports are presented.

Fifteen roentgenograms; 4 photomicrographs; 6 tables.

JOHN F. RIESSER, M.D.
Springfield, Ohio

Intralobar Bronchopulmonary Sequestration in Children: Diagnosis by Intrathoracic Aortography. Artemis P. Simopoulos, David J. Rosenblum, Harish Mazumdar, and Brian Kiely. J. Dis. Children **97:** 796–804, June 1959. (B. K., State University of New York, Brooklyn 3, N. Y.)

Intralobar sequestration, in which a portion of lung lies unconnected with the normal pulmonary circulation and bronchial tree, has rarely been recorded in pediatric literature. The authors report here 2 cases in which the diagnosis and analysis of blood supply were made by means of intrathoracic aortography.

Conventional roentgenograms in both cases revealed areas of disease in the left lung base region. Bronchograms showed no filling in the areas of infiltration. Catheterization of the descending aorta was then carried out *via* the right brachial artery, and seriograms were made during injection of the contrast medium. The aortograms disclosed aberrant arteries arising from the aorta entering and branching within the suspected segments in both patients.

Aortography appears to be a more dependable means of demonstrating the abnormal blood supply in sequestration of this type than angiocardiography or body-section radiography. The procedure determines the diagnosis in doubtful cases and, moreover, informs the surgeon in advance of the course and size of the arteries which he will encounter at operation.

Fifteen roentgenograms.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Trigger Mechanisms in Asthma. Richard H. Overholt. Dis. of Chest **35:** 587–596, June 1959. (New England Deaconess Hospital, Boston, Mass.)

Intractable asthma represents an intense and generalized bronchospasm which may be related to many factors, among which are allergy, emotional disturbances, imbalance of sympathetic and parasympathetic nervous control, and infection. Disturbances in one area of the bronchial system may act as "triggers" to set off a general bronchospasm. Denervation procedures interrupting afferent or efferent nerve pathways to the lung may afford relief from asthma but many such procedures will meet with failure if so-called "trigger mechanisms" are not eliminated.

As a result, intractable cases of asthma should have the benefit of a thorough investigation with an eye toward the existence of correctable anatomic defects such as enlarged lymph nodes impinging on or penetrating the bronchial tree and localized foci of bronchiectasis. Bronchography carefully done with special precautions and preparation for untoward reactions will be of most benefit. Selective segmental injections may be required.

At surgical exploration, "the surgeon inspects and overhauls the defective or abnormally functioning ventilatory organ. He liberates abnormally anchored segments, divides adhesions or bands, decorticates constricted segments, removes enlarged nodes or destroyed segments, denervates a spastic lung and works with it until all healthy segments are functioning properly."

Of 31 asthmatics treated surgically and followed for periods of eighteen months to twelve years, all improved to some degree. Three-fourths were significantly better. One-half of the entire number were considered to be well and free of asthma.

Three illustrative cases are reported.

Three roentgenograms; 11 drawings; 2 tables.

JOHN F. RIESSER, M.D.
Springfield, Ohio

Infrapulmonary Pleural Effusion with Particular Reference to Its Occurrence in Nephrosis. J. Scott Dunbar and Martine Favreau. J. Canad. A. Radiologists **10:** 24–33, June 1959. (Montreal Children's Hospital, Montreal, Que., Canada)

A series of 49 patients in the active stage of the nephrotic syndrome was reviewed through a study of clinical charts and chest films to determine whether evidence of infrapulmonary pleural effusion was present, and an attempt was made to find diagnostic roentgenologic features. Seventy-five per cent of the cases were believed to show definite evidence of fluid between the base of the lung and the diaphragm on one or both sides. The positive cases were surveyed with reference to characteristic film features that might permit recognition of infrapulmonary effusion. The following findings are thought to be of importance in identification.

1. "Reversed meniscus," representing an elevation of the base of the lung, convex upward, simulating simple elevation of the diaphragm.

2. Change in the contour of the lung base. The curve reaches its maximum height at approximately the junction of its middle and lateral thirds rather than at its center, as in simple elevation of the diaphragm. This is considered a reliable sign of infrapulmonary pleural effusion.

3. Posterior fluid collection. Lateral or oblique projections will usually show a small amount of fluid in the posterior costophrenic sinus ascending a short distance up the posterior chest wall with the patient upright. This also is a valuable sign of effusion.

4. Separation of the stomach bubble from the left leaf of the diaphragm.

5. Shift of fluid with posture change. Lateral decubitus views will reliably demonstrate the fluid flowing out from beneath the lung to take a new position along the lateral lower chest wall.

6. Mediastinal effusion. This sign presents as a small, sharply defined, thin mediastinal triangular density in the left lower chest, separating the lung from the mediastinum. It represents fluid ascending along the mediastinal parietal pleura. The finding was demonstrable in 8 of 39 patients and, though previously undescribed, is quite characteristic. At times it may simulate left lower lobe basilar collapse, but the shadow is thinner and better defined. It is continuous with the false diaphragmatic contour inferiorly and with the mediastinal border superiorly. Further, it does not conform to the shape of any segmental collapse and contains no "air bronchogram." If confusion exists, changing of the patient's posture, *e.g.*, to decubitus position, will produce a change in size and shape of the triangular mediastinal shadow referable to effusion.

7. The anterior costophrenic sinus tends to be clear.

8. A small amount of fluid is frequently seen in the lower end of one or both of the oblique fissures.

Each of the above points is illustrated by small radiographic reproductions.

A discussion is given of the physical characteristics and nature of the effusion to explain its behavior. Some points of interest include the following: An

amount of fluid considerably less than 250 c.c. should be recognized if special views are obtained, particularly the lateral decubitus. Fluid demonstration may be better achieved with exposures made during complete expiration.

Some differential points between the nephrotic syndrome and acute nephritis with respect to chest roentgenograms are given. In acute nephritis the heart is usually slightly enlarged, pleural effusion is uncommon, and pulmonary edema is frequent. On the other hand, pulmonary edema is not seen in nephrosis even when massive edema of all soft tissues supplied by the systemic circulation is present. In the typical nephrotic patient the heart appears to be "sunk low between the diaphragmatic arches."

Eighteen roentgenograms; 1 table.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Diaphragmatic Hernia as a Finding in the Chest Radiograph. B. F. Vaughan. Proc. Coll. Radiologists Australasia **3:** 42–51, June 1959. (Royal Perth Hospital, Perth, Western Australia)

A diaphragmatic abnormality must be considered in the differential diagnosis of any unexplained shadow in the lower third of either lung field. Harrington (Am. J. Roentgenol. **49:** 185, 1943. Abst. in Radiology **41:** 304, 1943) divided *congenital* hernias into two broad types.

1. *Hernias without a sac:* (*a*) A defect in the pleural peritoneal hiatus, the foramen of Bochdalek. Hernias of this type are almost always seen on the left; on the right, they are plugged by the liver. They may contain stomach, spleen, small intestine, omentum and, on occasion, kidney and ureter.

(*b*) Absence of the posterior portion of the diaphragm. This results in the well known gross congenital hernia, where most of the abdominal contents are found lying in the left chest. This condition is associated with hypoplasia of the lung on the affected side. Inflation cannot be accomplished by positive pressure, but if the infant survives operation, the lung slowly enlarges.

2. *Hernias with a sacs and due to a congenital diaphragmatic weakness:* These hernias are acquired later in life, often in middle age. Rarely they may be found in the very young.

(*a*) Through the esophageal hiatus. This is the most common form of diaphragmatic hernia, and the types and radiographic patterns are well known.

(*b*) Through the foramen of Morgagni. The foramina of Morgagni are small triangular spaces lying between the sternal and costal attachments of the diaphragm. The actual incidence of this type of hernia is difficult to determine, as it is frequently asymptomatic and probably contains only omentum. It is often manifest only as a mass lesion anteriorly at the right cardiophrenic angle and may be mistaken for a pericardial cyst. A study of the literature showed that, while a foramen of Morgagni hernia containing omentum or colon is usually not a serious condition, trouble must be anticipated if the stomach is included.

Traumatic hernias occur as a tear in the center of the dome of the left hemidiaphragm. The herniation may occur months or years after the injury or may develop immediately and not be detected. Hence, previous trauma should be suspected when a herniated viscus is unexpectedly found. There are times when it is most difficult to differentiate a diaphragmatic hernia from a localized eventration of the diaphragm.

Illustrative cases are included.

Twenty-six roentogenograms.

MAJ. MARTIN A. THOMAS, M.C.
MacDill AFB, Fla.

THE HEART AND BLOOD VESSELS

Simple Methods in the Diagnosis of Congenital Heart Disease. R. Astley. Brit. J. Radiol. **32:** 355–370, June 1959. (Children's Hospital, Birmingham, England)

This is an excellent paper reviewing the diagnostic signs of congenital heart disease which can be detected by good plain-film radiography and fluoroscopy.

The article is arranged to give a useful approach to any case of congenital heart disease. The first section on left-to-right shunts (characterized by lack of cyanosis, prominent pulmonary segment, and pulmonary plethora) is subdivided on the basis of the size of the aorta. A large aorta is found in patent ductus arteriosus and a small aorta in atrial and ventricular septal defects.

Other conditions discussed include anomalous venous drainage, coarctation of the aorta, pulmonary stenosis, complete transposition of great vessels, partial transposition, single ventricle, truncus arteriosus, and tricuspid atresia.

Beca ıse of the high concentration of valuable material, no adequate abstract of this paper is possible. It is highly recommended for reading and re-reading in its entirety.

Thirty-three roentgenograms; 6 diagrams; 2 tables.

RICHARD P. STORRS, M.D.
Los Angeles, Calif.

Angiocardiography in Diagnosis of Congenital Heart Disease in Infancy and Childhood. Israel Steinberg. J.A.M.A. **170:** 772–780, June 13, 1959. (170 E. 77th St., New York 21, N. Y.)

Angiocardiography is an important diagnostic tool, though it is not necessary in every case of congenital heart disease, since simpler measures may suffice. Complex cardiac malformations may be difficult to identify even after angiocardiography and catheterization studies. In the author's series only one fatality occurred in over 15,000 infants and children examined. The diagnostic information which may be afforded by angiocardiography makes so small a risk acceptable.

The author points out and illustrates salient angiocardiographic features in the valvular and vascular stenoses, simple shunts, anomalies of the large arteries, and some of the complex cardiac malformations.

Twenty roentgenograms.

WILLIAM MARTEL, M.D.
University Hospital, Ann Arbor, Mich.

Cine-Angiocardiography. R. Astley, C. G. Parsons, and A. L. d'Abreu. Proc. Roy. Soc. Med. **52:** 457–459, June 1959. (Children's Hospital, Birmingham, England)

Fourteen months experience with 109 cineangiocardiograms on infants and children revealed a high incidence of patent ductus arteriosus, septal defects, pulmonary stenoses, and Fallot's tetralogy. The diagnosis of patent ductus is considered to be highly accurate.

Both venous angiocardiography and cardiac cathe-

terization followed by selective angiocardiography were employed. Premedication and minimal anesthesia are required for short filming exposures. A Philips 5-in. image intensifier and 16-mm. Bolex cine camera are used with synchronization of shutter opening and x-ray exposure. Individual frame exposures are two milliseconds and the filming rate is 32 frames per second.

The *patent ductus* is best demonstrated in the left oblique position where a diastolic dilution defect in the enlarged pulmonary artery is the most constant sign. The entry of nonopacified blood is first seen as a translucency near the bifurcation often extending as far back as the valve. This gives an empty appearance which is immediately followed by systolic filling from the ventricle; thus there is a characteristic intermittent contrast filling and emptying of the pulmonary artery.

Septal defects may be determined from simple venous injections but localization and estimation of the size may require selective catheterization.

Valvular, infundibular, or *combined pulmonary stenoses* are demonstrated by injections with the patient in the right oblique position. Where there is an associated ventricular septal defect a separate injection in the left oblique position may be useful.

The authors had no deaths in a total of 254 angiocardiographic examinations. Reactions and technical failures were infrequent.

Eight figures; 1 table. JOHN F. RIESSER, M.D.
Springfield, Ohio

Interventricular Septal Defect Secondary to Nonpenetrating Injury. Neil E. Crow and Byron G. Brogdon. Arch. Int. Med. **103:** 791–795, May 1959. (Lackland AFB, Texas)

The authors present 2 cases of traumatic interventricular septal defects arising from nonpenetrating injury. The first patient was injured by a truck wheel passing over his thorax. When he was hospitalized, a loud systolic murmur was audible over the entire precordium. A chest film on admission demonstrated pulmonary contusion, with normal cardiac size and configuration. Dyspnea and edema developed, and a second film, four weeks after the first, showed generalized cardiomegaly and pulmonary hyperemia. At catheterization, an interventricular septal defect was noted. Surgical correction was undertaken, at which time three interventricular septal defects were found near the apex.

A twenty-four-year-old male was injured in an automobile accident. A severed femoral artery and comminuted femoral fracture necessitated multiple transfusions and immediate surgery. Pre-anesthesia examination revealed a harsh Grade 4 systolic murmur, with a thrill over the entire precordium. The next day, auricular fibrillation and cardiac decompensation developed. A recumbent chest film showed cardiomegaly to the left, with pulmonary hyperemia. The electrocardiogram was consistent with myocardial infarction. The patient was transferred to another hospital where evidence of a ventricular septal defect was found at catheterization.

The authors emphasize the importance of early recognition of heart trauma and point out that absence of rib fracture and delay in onset of radiographic changes do not exclude severe cardiac injury.

Eight roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

Clinical and Physiologic Studies in Ebstein's Malformation. W. R. Livesay. Am. Heart J. **57:** 701–711, May 1959. (Hermann Hospital, Houston 25, Texas)

Some 90 cases of Ebstein's anomaly of the tricuspid valve have been recorded to date. The basic defect is a downward displacement of one or more leaflets of the valve so that the upper portion of the right ventricular cavity is within the right atrium, functioning as part of the atrial cavity. The right ventricular cavity is thus quite small. A single case is reported.

Usually these patients become cyanotic after a delay of six to twenty-six years. There is generally good exercise tolerance in the presence of an enlarged heart. Physical findings are characteristic, as is the electrocardiogram. Roentgenography reveals an enlarged, globular heart and diminished pulmonary vascularity. Fluoroscopically, pulsations are diminished in all directions except for the middle portion of the left cardiac border in the area of the pulmonary conus, where they are seen to be more vigorous. Angiocardiography shows a large right atrium with stasis of the medium in this chamber. Poor filling of the pulmonary vessels is typical. Some investigators have demonstrated a nonopacified band in the anterior portion of the heart, which may represent the displaced tricuspid leaflet (Soloff *et al.:* Am. J. M. Sc. **222:** 554, 1951. Abst. in Radiology **59:** 601, 1952).

Cardiac catheterization is helpful in diagnosis as well. The pressures in the pulmonary artery and right ventricle are within the normal range.

Six roentgenograms; 2 photographs; 2 tracings; 1 table. ROGER M. STOLL, M.D.
New York, N. Y.

Postpericardiotomy Syndrome in Congenital Heart Deformities. John L. Johnson. Am. Heart J. **57:** 643–653, May 1959. (College of Medical Evangelists, Los Angeles, Calif.)

A syndrome similar to the postcommissurotomy syndrome occurs following pericardiotomy in patients without rheumatic heart disease. A pericarditis follows opening of the pericardium and is sometimes associated with pleural effusion or pneumonia. The syndrome occurs anywhere from a week to two months after operation.

The author encountered 11 examples of this condition in the past three years. Five of the patients were under ten years of age, and 5 were between ten and twenty. Fever was the first symptom in every instance. Other signs and symptoms were chest pain, apprehension, poor heart tones, friction rub, decreased breath sounds, and dullness (due to pleural effusion). Roentgen examination characteristically showed cardiac enlargement, diminished pulsations of the heart at fluoroscopy, pleural effusion, and pneumonia. Treatment included decreased activity or bed rest, antibiotics and, in some instances, pericardial tap. The majority of the cases showed complete clearing within thirty days.

The etiology of this condition is not clear, but it is presumed to be the result of trauma to the myocardium during the course of surgery and possibly intrapericardial bleeding.

Five case histories are included.

Fourteen roentgenograms; 8 tables.

ROGER M. STOLL, M.D.
New York, N. Y.

Isolated Infundibular Stenosis. S. Gilbert Blount, Jr., Philip S. Vigoda, and Henry Swan. Am. Heart J. 57: 684–700, May 1959. (University of Colorado Medical Center, Denver, Colo.)

Three cases of isolated infundibular stenosis (subvalvular pulmonic stenosis with intact ventricular septum) are presented.

In all 3 cases there was a clinical history of heart disease from birth. Fluoroscopically the pulmonary artery segment was prominent. Enlargement of the right atrium and ventricle was noted. The diagnosis in each instance was made by cardiac catheterization and was confirmed at surgery. All patients improved clinically following operation.

Since 1948 about 60 of these cases have been reported, of which the majority have been diagnosed by catheterization. The condition is caused by arrest of the normal involution of the bulbus cordis and is of two types: (1) A fibrous band at the junction of the infundibulum and right ventricle may produce a stenosis of the orifice of the infundibulum and divide the right ventricle in two. (2) A shrunken, thickened infundibulum may result in a fusiform stenotic outlet to the right ventricle.

Roentgen findings described in the literature include absence of poststenotic dilatation of the main pulmonary artery and a bulging of the lower left midsegment. Prominent pulsation of the main pulmonary artery with normal or decreased pulsation in the right and left pulmonary arteries is usually not seen, though this was observed in 1 of the authors' cases. In none of their patients was there a bulging of the left lower midsegment. In 1 case the roentgenogram suggested poststenotic dilatation of the pulmonary artery but this was not confirmed at surgery. In another the reverse was true.

Some Swedish authorities have used angiocardiography as a method of diagnosis with good results, but the authors have had no experience with this. Severe infundibular stenosis with patent foramen ovale may be confused with tetralogy of Fallot.

Seven figures, including 3 roentgenograms; 1 table.

ROGER M. STOLL, M.D.
New York, N. Y.

Right Atrial Myxoma. Martin S. Belle. Circulation 19: 910–917, June 1959. (Jackson Memorial Hospital, Miami, Fla.)

Primary tumors of the heart are relatively rare and difficult to recognize unless angiocardiography is done. In the case here reported, the patient was carefully studied at two centers, with diagnoses of tricuspid stenosis and Ebstein's anomaly, respectively. The author elected to do angiocardiography because catheter studies with an intracavitary electrode were not consistent with Ebstein's anomaly. A filling defect was seen and was interpreted as a myxoma attached to the right atrial septum, prolapsing through the tricuspid valve into the right ventricle. At surgery (under hypothermia) a polypoid pedunculated mass was found growing from the lower portion of the interatrial septum and obviously obstructing the inflow of blood to the right ventricle. The patient died twenty-four hours postoperatively. The tumor proved to be a myxoma.

Several findings are emphasized that may call attention to the possible diagnosis of right atrial myxoma: right-sided heart failure; calcification of the right heart; enlargement of the right ventricle and right atrium; electrocardiographic findings of a prominent P wave and low voltage over the right precordium simulating that found in Ebstein's anomaly, and marked variation in heart rate not related to any physiologic event or change in rhythm. The use of an intracavitary electrode catheter to rule out Ebstein's anomaly is suggested. Finally, analysis of the right atrial curve may lead one to suspect that other than valvular stenosis is present. Angiocardiography gives a definitive diagnosis.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Arachnodactyly Heart. F. S. P. van Buchem. Circulation 20: 88–95, July 1959. (State University of Groningen, Groningen, Netherlands)

The association of various aortic defects with arachnodactyly is well known. A more unusual finding is marked cardiac dilatation and myocardial hypertrophy without aortic pathology. Such a case is reported here.

Progressive cardiac enlargement was seen on plain films; catheterization and angiocardiography were not done. Death occurred some seven years after the first examination. At autopsy the extensive dilatation and hypertrophy were noted, accompanied by myocardial fibrosis. The valve rings were incompetent because of the dilatation and the valves were somewhat thickened, but there was no evidence of rheumatic fever or any other inflammatory disease.

A brother of the patient was examined and found to have some cardiac enlargement in addition to the usual features of Marfan's syndrome. The patient's mother also had Marfan's syndrome but no cardiac enlargement.

Six roentgenograms; 3 photomicrographs; 1 photograph; 1 chart; 3 electrocardiograms; 2 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Kinking of the Aortic Arch. Paul Ross. M. J. Australia 1: 864–866, June 27, 1959. (Melbourne, Victoria, Australia)

The author reports 3 cases of kinking of the aortic arch. Less than 50 cases of this anomaly have been recorded since 1951. It consists of a kinking of the aortic isthmus medially and anteriorly so that the descending portion of the arch passes downward, forward, and to the right to the region of insertion of the ligamentum arteriosum. The aorta then turns abruptly to the left and passes laterally and downward as the descending thoracic aorta. The kinking is associated with a short ligamentum arteriosum. The transverse portion of the aortic arch frequently lies higher than usual and it may extend further to the left. All these changes may also be seen in coarctation of the aorta, but in aortic kinking there is no constriction of the lumen.

There are no symptoms attributable to this deformity, and the only physical sign which may be found is a systolic murmur in some cases. Almost invariably, the sequence of events is as follows: The patient has an x-ray examination of the chest, and an abnormal shadow is seen in the left upper mediastinum. This prompts further radiographic investigation and eventually the diagnosis is made.

Lateral or left anterior oblique views will usually reveal the kinking of the aorta. Fluoroscopy may be helpful, as in some cases, but not all, expansible pulsa-

tion may be identifiable in the abnormal shadow. X-ray examination with barium swallow will often show an indentation in the left side of esophagus posteriorly, produced by the kinked isthmus, whereas the anterior indentation in the left side of the esophagus frequently seen in normal cases due to the aortic knob may be absent or diminished. Sometimes laminagraphy in the lateral or left anterior oblique position may be required for diagnosis. In the occasional case in which there is still uncertainty, aortic opacification is indicated.

Coarctation of the aorta, mediastinal tumor, aneurysm of the aortic arch, and patent ductus arteriosus enter into the differential diagnosis.

Ten roentgenograms. SHAWKI ASMAR, M.D.
Cleveland Metropolitan General Hospital

Experiences in Aortography by Femoral Artery Catheterisation with the Seldinger Catheter. B. F. Vaughan. Proc. Coll. Radiologists Australasia **3:** 17–23, June 1959. (Royal Perth Hospital, Perth, Western Australia)

Aortography has been performed almost solely by femoral artery catheterization with the Seldinger catheter for the last eighteen months in the Radiology Department of the Royal Perth Hospital. This paper consists of a series of case summaries and emphasizes some of the problems to be encountered in the use of this procedure. No difficulty has been experienced in penetrating the femoral artery or inserting the guide. The two main problems were difficulty in advancing the catheter through the iliac arteries, due to abnormal tortuosity, and impaction of the tip of the catheter in thrombus at the aortic bifurcation. The author also cautions against inserting the guide wire more than 3 inches in patients with significant sclerosis and mentions a case in which the iliac artery was perforated by the guide wire.

Among the cases reported are 3 illustrating the role of aortography in planning surgery for vascular insufficiency.

Sixteen roentgenograms; 1 photograph; 1 diagram.
MAJ. MARTIN A. THOMAS, M.C.
MacDill AFB, Fla.

Experiences with Seldinger's Technique of Arterial Catheterization. H. A. Luke. Proc. Coll. Radiologists Australasia **3:** 1–16, June 1959. (Alfred Hospital, Melbourne, Victoria, Australia)

The author briefly reviews the problems of arteriography and reports his experience with the Seldinger arterial catheter which he had used on 84 occasions since 1956 without complication.

In Seldinger's original article (Acta radiol. **39:** 368, 1953. Abst. in Radiology **62:** 466, 1954), he pointed out that the catheter has certain advantages over the needle method: the contrast material may be injected at any level in the aorta; the risk of paravascular injection is minimized; the patient may be placed in any position; the catheter may be left *in situ* without danger while the films are being studied, thus facilitating reexamination if necessary.

Briefly, the method consists in inserting a needle into a large artery such as the brachial, carotid, or femoral. Over this needle there is a closely fitting cannula with thin walls. After the cannula has passed into the lumen of the vessel, the needle is removed and is replaced by a long, flexible guide wire made from a spiral of stainless steel. The cannula is then removed and over the outside of the guide wire a polyethylene catheter is passed, with its tip shaped to fit the guidewire; the remainder of the catheter can be considerably larger. Because the catheter fits tightly into the puncture in the arterial wall there is no bleeding from the artery during the procedure. Once the guide wire has been removed, the catheter can be advanced without fears of damage to the aorta, provided a normal pulse is transmitted through it. If, for instance, the catheter were to pass into a thrombus, the pulse would immediately disappear and the catheter would then be withdrawn slightly. With refinement of technic, it is now possible to employ a curved opaque catheter which can be passed into almost any branch of the aorta.

The Seldinger catheter is being employed by the author for all cases in which it is desired to demonstrate either the aorta or any of its main branches. Whether it is introduced by way of the femoral or carotid artery depends on the clinical problems involved. For instance, demonstration of the aortic arch could be carried out either from above or below. Generally, a long catheter would be inserted from the femoral artery, as this is easier, but, if an aneurysm of the descending aorta were suspected, it would obviously be safer to carry out the catheterization from either the right or the left carotid artery, with the tip of the catheter in the ascending aorta. Similarly, demonstration of the abdominal aorta is generally carried out from below, but, if there are excessively tortuous iliac arteries, or an aneurysm is suspected, it is safer to insert a curved catheter into the right carotid artery, turning it down the aortic arch and into the descending aorta to the appropriate level.

A catheter can also be used for either carotid or vertebral cerebral angioarteriography in selected cases, though for the most part standard needling technics are employed to demonstrate the cerebral vessels.

Twelve case summaries illustrate varied applications of the catheter technic.

Fifteen roentgenograms with accompanying line drawings. MAJ. MARTIN A. THOMAS, M.C.
MacDill AFB, Fla.

Cine-Aortography for the Visualization of the Aortic Valve and Coronary Arteries. Graeme Sloman. Proc. Roy. Soc. Med. **52:** 460–461, June 1959. (St. George's Hospital, London, England)

Open operative approaches to the diseased aortic valve call for a more precise preoperative assessment of the anatomy and function of the valves. A technic of cine-aortography for visualization of the aortic valve and coronary arteries was developed in studies on 25 dogs; the procedure, limited to the valve because of field size, was applied to 8 patients.

A 35-mm. camera mounted on a 5-inch image intensifier was employed. Film exposure was at the rate of 32 frames per second. Films were optically reduced to 16 mm. for viewing. The contrast media used were 76 per cent Urografin and 90 per cent and 85 per cent Hypaque. A side-opening NIH catheter was introduced under fluoroscopy after arterial exposure (brachial in the patients), and positioned with the tip about 2 cm. above the aortic valve. With the patient in the left anterior oblique position, a small test injection was made to verify the location of the catheter. The definitive injection consisted of 1 ml. contrast medium per kg. body weight.

The following indications for this procedure are given: (1) in aortic stenosis and regurgitation, to study movement of aortic valve leaflets and to assess aortic regurgitation; (2) in mitral disease with an early diastolic murmur, to exclude aortic regurgitation; (3) to outline aortic aneurysms or aneurysms of the sinuses of Valsalva; (4) to demonstrate aortic fistulas.

Two roentgenograms. JOHN F. RIESSER, M.D.
Springfield, Ohio

New Technique of Contrast Visualization of the Distal Aorta, Pelvic and Lower Extremity Arterial System in Obliterative Vascular Disease. Billy P. Sammons and H. Paul Mahin. Am. J. Roentgenol. **81:** 835–840, May 1959. (B. P. S., U. S. Naval Hospital, Pensacola, Fla.)

The authors describe a technic for arteriography of the lower abdominal aorta, iliac arteries, and lower extremity arteries in obliterative vascular disease which usually makes insertion of a needle in the abdominal aorta unnecessary. The femoral artery on the less affected side is percutaneously punctured with a 16-gauge Lindmann needle. A tourniquet is then placed as far cephalad as possible on the thigh of the same side, and 35 c.c. of 50 per cent Hypaque is injected by hand while the patient performs a Valsalva maneuver. A single film is made of the lower abdomen and pelvis, followed by serial films of the opposite femoral artery at one-second intervals. The first film shows the iliac arteries and the abdominal aorta up to the level of the renal arteries. Subsequently, the tourniquet is removed and another injection is made to demonstrate the vessels of the ipsilateral leg.

If the aorta is completely occluded, lumbar aortography is performed with 10 c.c. of 50 per cent Hypaque to show the proximal extent of the block.

This technic was used successfully in 86 patients without significant morbidity.

Fifteen roentgenograms; 1 diagram.

GARTH R. DREWRY, M.D.
Tampa, Fla.

Roentgen Findings in Aneurysm of the Descending Thoracic Aorta. James G. Davis and Philip Winsor. Am. J. Roentgenol. **81:** 819–825, May 1959. (P. W., 1200 N. State St., Los Angeles, Calif.)

Seven cases of aneurysm of the descending thoracic aorta are reported, 4 proved by thoracotomy and 3 at autopsy. Of these, 5 were correctly diagnosed preoperatively, 1 was called a bronchogenic cyst, and 1 was believed to be a bronchogenic carcinoma. Three were syphilitic, and 4 were arteriosclerotic.

In the postero-anterior roentgenogram, the chest aneurysm may present as a mass in the right cardiophrenic angle or either hilar area; it will stay with the descending aorta in all projections. Calcifications in the walls of the aneurysm and erosion of adjacent vertebrae or ribs may occur. Fluoroscopic demonstration of pulsation is not very helpful, since transmitted pulsations are difficult to distinguish from expansile pulsations, and thrombosed aneurysms may not pulsate. Angiocardiography or aortography may outline the aneurysm unless it has a narrow opening or is filled with a thrombus.

Thirteen roentgenograms.

GARTH R. DREWRY, M.D.
Tampa, Fla.

Simulated Dissecting Aneurysm. Case Report. Leonard C. Doubleday. Texas State J. Med. **55:** 308, April 1959. (1010 Louisiana, Houston 2, Texas)

An elderly man complaining of severe back pain was admitted to the hospital because of an abnormal chest roentgenogram. A marked change in the appearance of the thoracic aorta as compared to a film made two weeks earlier led to a diagnosis of dissecting aneurysm, and aortography was performed. The aortogram revealed rather marked tortuosity of the thoracic aorta but no evidence of dissection. In a lateral projection a recent compression fracture of the first lumbar vertebra was observed. Questioning disclosed that the patient had fallen a few days prior to admission. The difference in the appearance of the aorta is explained on the basis of change in the conformation of the thoracic cage following the fracture of the spine. This change produced an increase in tortuosity of the arteriosclerotic thoracic aorta.

Four roentgenograms.

Roentgen Signs of Contrast Material Dissection of Aortic Wall in Direct Aortography. Delbert E. Boblitt, Melvin M. Figley, and Earl F. Wolfman, Jr. Am. J. Roentgenol. **81:** 826–834, May 1959. (University Hospital, Ann Arbor, Mich.)

In a series of 425 translumbar aortographic examinations inadvertent intramural injections of varying amount occurred in 42 patients. The only serious or significant complications in the whole series, including 3 deaths, were in patients in whom this accident occurred. Details of the 3 fatal cases are included in another paper (Wolfman and Boblitt: Arch. Surg. **78:** 629, 1959. Abst in Radiology **74:** 326, 1960). In 2 of them dissecting aneurysms surrounded the renal arteries, producing uremia.

The cardinal sign of intramural injection is a sharply demarcated dense collection of contrast medium showing no evidence of mixing with nonopacified blood. The column of contrast material equals or only slightly exceeds the diameter of the vessel injected. Additional evidence of intramural injection is extension of the column of medium more than the usual distance proximal to the needle or failure to fill the distal aorta and its branches in a patient with good femoral pulses. If part of the medium in the wall re-enters the lumen, that remaining will appear as a cast of the aortic wall.

If the intramural injection occludes a vessel, delayed films may show persistent opacification of the affected viscus (such as kidney or rectum) due to loss of normal perfusion pressure.

Extramural injections were less common than intramural injections and were easily distinguished by the irregular extramural distribution of the contrast medium.

The authors feel that many of the previously reported complications of aortography were due to intramural injections leading to dissection of the wall and occlusion of the vessels. In spite of the usual precautions, including use of a short bevel needle, puncture of the aorta only once, manual instead of high-pressure mechanical injections, and avoidance of injection, unless a good pulsatile flow of blood issues from the needle, an intramural injection may occur. A test roentgenogram with about 5 c.c. of contrast medium should therefore always be obtained. If this shows any sign of intramural injection, the ex-

amination should be discontinued, a delayed abdominal film should be made within a few minutes to detect abnormal retention of medium by the kidneys or other organs, the patient should be observed closely for signs of dissection, and injection should not be attempted again for at least twenty-four hours.

Thirteen roentgenograms; 1 photograph.

GARTH R. DREWRY, M.D.
Tampa, Fla.

An Improved Method of Coronary Arteriography. Louis H. Frische and Charles T. Dotter. Dis. of Chest **35:** 546–553, May 1959. (University of Oregon Medical School, Portland, Ore.)

The authors report their studies of the coronary arteries of dogs, by the technic of aortic occlusion and proximal injection of a contrast medium. More than 1,000 procedures were done in 76 animals. A Type 1 Dotter-Lukas double-lumen balloon catheter was introduced into the radial artery and advanced in retrograde fashion under fluoroscopic control to the root of the ascending aorta. As rapidly as possible, the balloon was inflated with a volume of CO_2 or N_2O adequate to produce complete aortic occlusion. Then, as contrast medium was quickly injected through the second lumen, serial radiography was done at the rate of one or two films per second for six seconds. The balloon was then deflated and the catheter removed.

In virtually all instances excellent opacification of the coronaries was obtained. The additional advantage of this technic is the feasibility of using small quantities of dilute contrast material, reducing the likelihood of side-effects due to the medium *per se*. Thorotrast was found to be the agent of choice, having no more effect on the myocardium than normal saline. No deaths nor significant electrocardiographic changes followed any procedure. All blood pressure alterations were transient.

This technic has been applied to human beings in only two instances, but in neither of these was it possible to produce total aortic occlusion. On the basis of other work done in laboratory animals, the utilization of acetylcholine to induce cardiac arrest in conjunction with occlusion is considered a promising possibility.

Eleven figures, including 8 roentgenograms.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Occlusive Disease of the Carotid Arteries. Allen Silverstein. Circulation **20:** 4–16, July 1959. (Mount Sinai Hospital, New York, N. Y.)

Fifty cases of carotid occlusion were studied. 47 demonstrated by angiography and 3 at autopsy. In 36 patients the onset of symptoms was sudden but in the other 14 it was gradual, and in 3 of these there was some intermittency. Neurological symptoms and signs varied greatly, weakness being predominant.

Plain skull films showed a pineal shift in 2 patients (undoubtedly because of cerebral edema). Carotid calcification was seen in 2 of 21 cases in which it was sought. Seven of 13 pneumoencephalograms showed symmetrically dilated ventricles with slight displacement in 2 others.

The most common site of occlusion demonstrated by arteriography was in the internal carotid in the neck (43 of the 50 cases). In only 2 patients was there progression of the condition seemingly caused by the arteriographic procedure; in 2 others there were transient neurological deficits.

Ten of the 50 patients had died at the time of the report, from two days to two years after the onset of symptoms; 17 were improved, while the rest were unchanged or lost to follow-up.

Anticoagulant and surgical therapy are discussed at length. It is pointed out that anticoagulants seem to benefit a few (particularly those with intermittent symptoms) but they carry a 5 per cent risk of cerebral hemorrhage. Surgical procedures devised so far do not seem to be the answer except in most recent occlusions.

When considering whether or not arteriography is to be done, it is important to realize not only that carotid occlusive disease may resemble a brain tumor very closely, but also that the reverse is true. The clinical course, severity, and symptoms and signs vary greatly in carotid occlusion.

Two roentgenograms; 1 graph; 3 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Extrapulmonic Stenosis of the Pulmonary Veins. Jay Bernstein, Anthony C. Nolke, and Joseph O. Reed. Circulation **19:** 891–897, June 1959. (Children's Hospital, Detroit, Mich.)

A single case is reported in which there was severe stenosis of the pulmonary veins at the junction with the left atrium. The etiology was probably congenital and there was associated endocardial thickening of the left atrium.

Frequent upper respiratory infections and hemoptysis were the leading symptoms at the age of four. Angiocardiography showed dilatation of the pulmonary artery but no shunt. Thoracotomy was done and the right upper lobe was resected "because it was firmer than the others." Extensive organizing thrombi were found in the arteries and veins. Two years later the patient was re-admitted because of dyspnea, fatigue, hemoptysis, fever, and cyanosis. Death occurred one month after admission, four hours after the onset of severe symptoms suggesting acute cardiac failure.

The autopsy findings included cardiac enlargement, severe stenosis of the pulmonary vein orifices, extensive proliferation of vessel walls, and thrombosis in both the arteries and veins. The arterial changes were probably on the basis of pulmonary hypertension which arose as a compensatory mechanism to increase the flow through the narrowed orifices. Collateral circulation through the bronchial veins was extensive, accounting for the hemoptysis.

Two roentgenograms; 6 photomicrographs; 2 photographs.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Enlargement of the Innominate and Subclavian Arteries, Simulating Mediastinal Neoplasm. Robert A. Green. Am. Rev. Tuberc. **79:** 790–798, June 1959. (VA Hospital, Ann Arbor, Mich.)

Four cases of superior mediastinal masses caused by enlargement of the innominate and right subclavian arteries are reported. The diagnosis was confirmed in 2 at autopsy, in 1 at surgery, and in the other by means of angiocardiography. All of the lesions presented as mass densities which were clearly defined

laterally and extended upward from the region of the ascending aortic arch to the apex of the lung. Superiorly the masses do not appear to be quite as clearly defined as they are inferiorly. Fluoroscopy revealed questionable expansible pulsation in only 1 of the 4 patients. No definite pulsation could be demonstrated in the others.

When the innominate artery enlarges or elongates, it usually projects to the right, so that a mass is produced, extending to overlie the right upper lung field. The most common case is probably buckling or kinking of the artery associated with arteriosclerosis and hypertension. Elongation of the aorta, which often occurs in these conditions, tends to accentuate the buckling. Aneurysm occurring in the innominate, or in the subclavian near the innominate, is another cause of enlargement with production of a mass.

Differential diagnosis may be difficult, since a number of lesions can result in mass shadows in the area. They include benign and malignant primary neoplasms of the various lymphatic, glandular, and connective-tissue structures, metastatic tumors, cysts, and occasionally inflammatory or granulomatous processes. Aneurysm of the innominate artery may produce a clinical picture leading to the diagnosis. There is a palpable mass at the base of the neck on the right, associated with cough, hoarseness, dysphagia, pain, pupillary abnormalities, and clubbing of the fingers. Buckling or elongation of the innominate artery does not ordinarily produce symptoms, so that the major findings are those on the roentgenogram. The usual roentgenographic feature is a smooth density which arises at the level of aortic arch and extends upward in the superior mediastinum. The lateral aspect of the mass is usually convex and it often tends to be more clearly defined inferiorly than superiorly. When such a lesion is visualized, the diagnosis can usually be made, particularly if expansile pulsations can be demonstrated fluoroscopically. When there is some doubt, retrograde aortography or angiocardiography can be used to confirm the diagnosis.

Nine roentgenograms; 1 photograph.

JOHN H. JUHL, M.D.
University of Wisconsin

Retrograde Pelvic Venography. C. G. Helander and Å. Lindbom. Acta radiol. **51:** 401–414, June 1959. (Karolinska Sjukhuset, Stockholm, Sweden)

Retrograde pelvic venography was done in 304 patients from fourteen to seventy-three years of age (285 females and 19 males), with bilateral femoral vein puncture and injection *via* indwelling venous catheters of 30 c.c. of contrast medium simultaneously in about four seconds (60 c.c. total). The technic was similar to that described by Helander and Lindbom (Acta radiol. **44:** 410, 1955. Abst. in Radiology **67:** 616, 1956). In 95 per cent of the cases the vena cava was compressed by an external band or balloon technic at the level of the umbilicus. Three of four serial films were obtained beginning on completion of the injection.

The normal variations of the venous system of the pelvis are described.

Two hundred and twenty-seven patients in this series had uterine carcinoma and in 50 of these deformities of the iliac veins were demonstrated, due to primary or metastatic tumor. Other findings encountered in the series were: 4 recent thrombi, 4 post-thrombotic deformities, and 46 cases of venectasia.

One fatality occurred, in a 59-year-old obese female with Stage III carcinoma of the cervix, seven days after pelvic venography, due to pulmonary emboli. Thrombi found in the pelvic veins at autopsy were thought to be due to the patient's remaining completely immobile in bed after the trauma of venous catheterization. The authors recommend that patients be up and around immediately after examination.

Twenty-one roentgenograms.

JOSEPH E. WHITLEY, M.D.
Bowman Gray School of Medicine

Percutaneous Selective Angiography of the Internal Mammary Artery. Ored Arner, Paul Edholm, and Per Ödman. Acta radiol. **51:** 433–438, June 1959. (Karolinska Sjukhuset, Stockholm, Sweden)

The authors describe a technic for angiographic visualization of the internal mammary artery and its branches. A polyethylene catheter with a curved tip is introduced percutaneously into the brachial artery and maneuvered, under fluoroscopic control, until the tip rests in the origin of the internal mammary artery. After a test injection to verify the position of the catheter, 15 c.c. of Urografin 45 per cent is injected manually. Six cases were examined in an attempt to find reliable angiographic differences between cancer of the breast and fibroadenomatosis, but the method was found to have no differential value. It was possible, however, to study communicating vessels, such as intercostal arteries and their branches.

Five roentgenograms; 2 diagrams.

DAMON D. BLAKE, M.D.
Bowman Gray School of Medicine

Functional Ascending Phlebography of the Lower Extremity by Serial Long Film Technique. Evaluation of Anatomic and Functional Detail in 62 Extremities. James A. DeWeese and Stanley M. Rogoff. Am. J. Roentgenol. **81:** 841–854, May 1959. (Strong Memorial Hospital, Rochester 20, N. Y.)

The authors describe their technic for phlebography of the lower extremities, by which the major deep veins of the calf and thigh were demonstrated successfully by one injection in the majority of the 62 extremities examined. The patient was placed semierect (60° above the horizontal plane), and a needle or small catheter, connected by a three-way stopcock to a bottle of saline, was introduced into any superficial vein on the dorsum of the foot. With a rubber tourniquet placed tightly around the ankle, 40 c.c. of 50 per cent Hypaque was injected in one minute. The first 14 × 34-inch film was then exposed. After removal of the tourniquet, the patient raised himself on his toes ten times and a second film was made. Following the procedure the saline solution was rapidly flushed through the catheter or needle.

In normal legs, the main deep veins (anterior tibial, peroneal, and posterior tibial) exhibited a uniform tapering outline with several valves present; the greatest width varied between 0.4 and 0.9 cm. Sural veins, draining from the gastrocnemius muscle into the popliteal vein, were frequently seen. Short segments of perforators ending at a competent valve without filling the superficial veins were also commonly observed.

In postphlebitic legs, the main deep veins were usually irregular in outline and valveless, but not

dilated. There were numerous valveless and frequently tortuous communicators and collaterals.

In extremities with varicose veins the main deep veins were in general normal in appearance, or occasionally widened. The visible communicators and collaterals were increased in number.

In normal thighs the popliteal, superficial femoral, and deep femoral veins were of uniform caliber (greatest width of the popliteal 1.2 cm. and of the superficial femoral 1.6 cm.) except for slight dilatation at the valves, of which there were one or two in the popliteal and one to six in the superficial femoral vein.

In postphlebitic thighs, all the main deep veins were abnormal, but not dilated. Some were recanalized with irregular valveless walls. Some were obliterated, with only faint lines of opacity along their course, having the appearance of venae comitantes.

In the majority of cases of varicose veins, the deep thigh veins appeared normal, but many were dilated with smooth valveless walls.

Films made after exercise showed very little contrast material remaining in the calf veins and decreased concentration in the thigh veins in normal subjects. In postphlebitic or varicose extremities, emptying of the calf veins tended to be poor in the presence of abnormal valveless thigh veins or an increased number of communicators and collaterals in the leg.

Sixteen roentgenograms; 5 tables.

GARTH R. DREWRY, M.D.
Tampa, Fla.

THE LYMPHATICS

Lymphography of the Deep Lymphatic System of the Thigh. P. Málek, J. Kolc, and A. Belán. Acta radiol. **51**: 422–428, June 1959. (Institute for Clinical and Experimental Surgery, Prague, Czechoslovakia)

A method of lymphography is described which makes possible the demonstration of the deep lymphatic system of the popliteal region and of the thigh. The authors inject 11 per cent patent blue in water into the outer side of the heel to identify the lymph channels. An incision is then made below and behind the external malleolus where lymphatic vessels running upward, and perhaps backwards from the level of the heel, are generally found. A vessel running toward the popliteal fossa is isolated and the contrast medium is injected.

The lymphographic appearances are as follows: In the upper two-thirds of the calf usually one (but occasionally two) lymphatic vessels may be seen proceeding medially to end in a superficial lymph node. The system of deep-seated popliteal nodes is then filled (this system is variable in regard to the number and size of the nodes; occasionally only one popliteal node is found). The lymphatic vessels may then be followed in the thigh, where one, several, or even a bundle of them may be seen accompanying the femoral artery to the inguinal region and then into the pelvis. These vessels sometimes proceed through the deep-seated inguinal nodes and accompany the femoral artery. The deep vessels lie more medially in the distal parts of the thigh as seen in the anteroposterior projection. In the lateral projection the two systems are superimposed, but may still be distinguishable, particularly in the popliteal region.

Ten roentgenograms; 2 diagrams.

JAMES F. MARTIN, M.D.
Bowman Gray School of Medicine

THE DIGESTIVE SYSTEM

Radiologic Physiology of the Esophagus: New Studies on the Active Motility of the Esophagus. L. Turano. Fortschr. a. d. Geb. d. Röntgenstrahlen **90**: 527–546, May 1959. (In German) (Istituto di Radiologia dell' Università, Rome, Italy)

Numerous investigations have been made of the physiology of the esophagus. Earlier examinations, however, have not sufficiently analyzed the peristaltic activity of the cervicothoracic esophagus. The existence of so-called secondary peristalsis is still denied by some authors. The tertiary contractions have not been well differentiated from peristaltic movements. The question whether the cardia acts as a sphincter or a valve is not definitely settled, and the co-ordination of the tone in the region of the cardia with peristaltic activity has not been studied.

The author has applied a new technic to the investigation of these problems. Cineradiography was combined with pressure recordings from three different esophageal sites. The pressure recordings were obtained by manometers connected to thin rubber bladders, of which the most distal one was placed in the region of the cardia. Swallowing and respirations were recorded simultaneously.

On the basis of his findings the author reaches the following conclusions: (1) Primary peristalsis, initiated by the swallowing act, is associated with a decrease in tone of the cardia region. (2) Secondary peristalsis may be initiated from any part of the cervicothoracic esophagus by local increase in pressure, the peristaltic wave starting approximately 10 cm. proximal to the initiation site. It is associated with a decrease of tone in the region of the cardia. (3) Segmental contractions of the cervicothoracic esophagus occur. They are not propulsive and are not associated with a decrease of tone in the region of the cardia. (4) A relatively high tone is present in this region when the esophagus is at rest, decreasing with peristaltic activity. This indicates a sphincter function of the cardia rather than a valve function.

Disturbances in the coordination of the tone of the cardia with the peristalsis of the cervicothoracic esophagus explain such conditions as achalasia of the cardia and gastroesophageal reflux.

Thirteen figures. ERIK CARLSSON, M.D.
Edward Mallinckrodt Institute of Radiology
St. Louis, Mo.

Yield of Gastric Carcinoma from Radiologic Screening. John R. Amberg, Edgar N. Gipson, Alexander R. Margulis, and Leo G. Rigler. Gastroenterology **36**: 796–800, June 1959. (J. R. A., Milwaukee County Hospital, Milwaukee, Wisc.)

From March 1, 1948, through Dec. 31, 1954, a total of 6,968 persons over the age of forty-five (3,400 men, 3,568 women) were registered at the Cancer Detection Center at the University of Minnesota. Of this group, 3,210 were selected for roentgen examination on the following criteria: achlorhydria or hypochlorhydria, occult blood in stools, unexplained hypohemoglobinemia, vague gastric symptoms, a family history of cancer of stomach, failure of passage of a gastric suction tube. Six thousand nine hundred and twenty seven examinations were completed within seven years.

Fifteen cases of gastric carcinoma were found, representing one case out of every 493 roentgen examina-

tions or one out of every 447 patient years of observation. Six of these patients were completely asymptomatic. Eight experienced weight loss or stomach symptoms; 1 had melena. Only 1 had symptoms for more than one year. Physical examination was negative in 13 patients. None had a free gastric acid value over 30°. In 3 cases the stools were guaiac-positive. In 14 of the 15 cases the primary indication for roentgen examination was the low gastric acidity. In the remaining case the gastric tube could not be passed at the screening examination.

Six cases were found at the first yearly examination, 4 at the second, 3 at the third, and 1 each in the fourth and fifth years. In all cases a tumor was demonstrable on roentgen examination. Nine were diagnosed as malignant, 3 benign, and 3 doubtful.

Surgery was performed in 13 cases. In 6 of the 13 patients operated upon (40 per cent) there was no evidence of spread beyond the confines of the stomach. This proportion is about three times that in ordinary practice. The lesions measured from 2 cm. to over 6 cm. They were mostly of polypoid type.

While surveys of this type have their advantages, they are not without disadvantages. The expense is considerable; they require a great deal of time of highly trained personnel; small lesions are sought, and false positive cases are inevitable. The possibility of detrimental somatic effects from repeated radiation exposure is not yet known.

Three tables.

ZOLTAN SZALONTAY, M.D.
Mercy Hospital, Pittsburgh

Pouch Formation of the Gastric Fundus as a Radiological Sign of Carcinoma of the Cardia. A. Elkeles. Brit. J. Radiol. **32:** 404–407, June 1959. (Prince of Wales's General Hospital, London, N. 15, England)

The author presents 7 cases of carcinoma of the cardia in which a pouch-like protrusion of the fundus was observed. Previously, he had reported 5 other cases in which this sign proved to be a valuable aid in diagnosis (Brit. J. Radiol. **17:** 251, 1944).

Carcinoma of the cardia most often arises in the medial half of the fundus. Occurrence of a pouch at this site may be due to anatomical and physiological reasons. This region of the stomach has a thin muscular coat and is under greater strain than any other portion of the organ except the pylorus. As it leaves the cardia, food spurts against this area and may lead to pouch formation if the wall is weakened by an infiltrating neoplasm.

In one patient of the present series, pouch formation was the only sign observed at the first examination. Later examinations revealed ulceration and a polypoid tumor. In one other case, observation of a pouch led to careful scrutiny of the cardia, where slight distortion of the terminal esophagus and minimal soft-tissue infiltration in this vicinity were seen. In a third case, a carcinoma of the pancreas invaded the posterior wall of the cardia and a large irregular pouch was demonstrated.

The diagnosis of carcinoma of the cardia should not be based solely on the presence of a pouch, but the latter sign should lead to careful examination for additional evidence of a neoplasm.

Eleven roentgenograms.

SAMUEL B. HAVESON, M.D.
Lynwood, Calif.

The Peutz Syndrome: Report of an Affected Family. Michael Katzen, R. Glyn-Thomas, M. F. Barrkman, and Anthony J. Leonsins. South African M. J. **33:** 492–496, June 13, 1959. (University of Witwatersrand, Johannesburg, Union of South Africa)

The Peutz syndrome (mucocutaneous pigmentation and gastrointestinal adenomatous polyposis inherited through a mendelian-dominant gene) is described in a mother and two daughters. This the authors believe to be the fifteenth affected family to be described in the literature. A distinction must be made between this syndrome and familial polyposis coli, where polypi are not found in the small bowel and there is no oral pigmentation. Intussusception is a classical complication of the Peutz syndrome; it occurred in 2 of the authors' cases. It may be progressive or transient. Other presenting complaints are diarrhea, intestinal bleeding, prolapsed rectal polyp, oral pigmentation.

Meticulous roentgen studies should be made in all cases showing the typical pigmentation. In the stomach, polypi are seen as rounded filling defects disturbing the normal rugal pattern when demonstrated by prone and supine barium mucosal studies. A compression cone and serial films are used in examining the duodenum. Between the duodenojejunal flexure and cecum, polypi are notoriously difficult to demonstrate. Since intussusception may be precipitated by the barium meal, the authors have devised a special technic of examination in which 60 c.c. of a water-soluble opaque medium is administered through a nasogastric tube with the tip lying within the duodenum. The small bowel is gently filled with air and the progress of the agent plus air is observed under the screen at short intervals, films being taken approximately every fifteen minutes.

Points in favor of prophylactic clearance of small-bowel polypi are: (*a*) The patient may die from the effects of multiple intussusceptions or anemia. (*b*) The tumors are considered premalignant by some, a probably untenable argument. Reasons against surgical clearance are: (*a*) The polypi may be so extensive that removal leaves behind too small an amount of bowel for adequate function. (*b*) The tumors grow sporadically at different ages and removal of one crop does not guarantee that a further growth in another section will not occur. (*c*) Some tumors not visible to the naked eye may be left behind.

While there is no incontrovertible evidence that tumors occurring in the large bowel are premalignant, it is probably safer to excise them. Local resection or excision with careful postoperative follow-up is considered the procedure of choice.

One roentgenogram with accompanying diagram; 1 photograph; 2 drawings.

Benign Tumors in the First Portion of the Duodenum. Case Presentations and Differential Diagnosis. Michael J. Healy and Robert B. Connor. Texas State J. Med. **55:** 300–304, April 1959. (M. J. H., St. Paul Hospital, Dallas, Texas)

Two cases of benign polypoid tumors of the first portion of the duodenum are reported. Both tumors were demonstrated roentgenologically and the diagnosis was established surgically. Both patients complained of vague upper abdominal distress, with a hint of partial obstruction occurring intermittently in each. The roentgen findings in these 2 cases were remarkably similar, although in one the histologic diagnosis was "local-

ized Brunner's gland hyperplasia with associated polyp formation" and in the other "leiomyoma." The tumors were of approximately the same size and were attached firmly to the duodenal wall by a broad pedicle. They could not be moved within the duodenal bulb. In the second case there were actually two leiomyomas in the duodenal bulb, but the large one dominated the roentgen picture.

The authors believe that, when a round, sharply defined filling defect, a broad pedicle, and firm attachment to the duodenal wall are demonstrated radiologically, a diagnosis of benign duodenal tumor is warranted. Operative removal is indicated and is usually curative. Immediate frozen section should be done on all of these tumors to exclude the remote possibility of cancer. The differential diagnosis is discussed.

Nine roentgenograms; 2 photomicrographs.

Intramural Hematoma of the Duodenum. Report of a Case. Ira A. Ferguson, Jr., and William J. Goade, Jr. New England J. Med. **260:** 1176–1177, June 4, 1959. (Lynn Hospital, Lynn, Mass.)

A 24-year-old man entered the hospital two days after the onset of severe epigastric pain with vomiting. No history of trauma was obtained. Positive clinical findings included mild distention of the upper abdomen with severe tenderness. Blood studies were generally negative but a mild elevation of serum amylase was shown. Three days after onset frank jaundice developed. An upper gastrointestinal series showed complete obstruction to gastric emptying. A small amount of barium trickling into the duodenum suggested compression by an extrinsic mass. A repeat gastrointestinal study five days later showed less severe obstruction, with a large extramucosal mass involving the entire duodenum to the ligament of Treitz. Portions of the lumen were widened, with crowding together of the valvulae conniventes and production of a "coil-spring" appearance mimicking intussusception. Because the obstruction persisted, surgery was performed on the ninth hospital day. An enormous hematoma was found involving the entire duodenal bulb and descending duodenum, with extension into the retroperitoneal space. The hematoma was drained from behind the duodenum and the subsequent course was uneventful.

A review of reports of similar cases indicates that about two-thirds of the patients have a definite history of abdominal trauma, usually of a nonpenetrating type. Extension of the hematoma may produce transitory obstruction of the bile duct, as apparently occurred in the case reported here.

The authors feel the radiographic demonstration of an extramucosal mass, widening of the lumen of the duodenum, swelling of the mucosa proximal to the main defect, and a coil-spring appearance simulating intussusception but without shortening or inner lumen constriction should lead to a diagnosis of intramural hematoma.

Two roentgenograms. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Leiomyosarcoma of the Small Intestine. Report of Four Cases. Jorge W. Mayoral and John H. Kier. Gastroenterology **36:** 848–855, June 1959. (J. H. K., VA Medical Teaching Group Hospital, Memphis, Tenn.)

The authors collected 26 cases of leiomyosarcoma of the small intestine from the recent literature, to which they add 4. The leiomyosarcomas of the small intestine are apparently slow growing tumors and affect all ages. The youngest of the 30 patients in this series was seven months old and the eldest seventy years. The sex ratio was 20 males to 9 females. The most frequently noted symptoms were abdominal pain, either acute or chronic bleeding, weight loss, and intestinal obstruction. Rupture of the small bowel is a serious complication.

A palpable abdominal mass was present in more than 50 per cent of the cases. Despite their slow growth, these tumors metastasize frequently to the liver. Other sites of metastatic involvement are, in order of frequency, the peritoneum, mesentery, omentum, regional lymph nodes, pancreas, and bones.

Symptoms suggesting recurrent bowel obstruction and melena of undetermined origin call for a barium-meal study of the small intestine. Roentgen examination is particularly helpful, as in more than half of the cases the tumor was first found radiographically.

Two roentgenograms; 1 photograph; 1 table.
ZOLTAN SZALONTAY, M.D.
Mercy Hospital, Pittsburgh

Meckel's Diverticulum: A Case Diagnosed by X-Ray. Claude W. Barrick and Kenneth E. Fry. Arch. Surg. **78:** 934–936, June 1959. (Jefferson Medical College Hospital, Philadelphia, Penna.)

A 25-year-old white male entered the hospital with acute abdominal complaints, including cramps, diarrhea, vomiting, and rectal bleeding. Blood pressure was lowered and there was some evidence of blood loss on examination of peripheral blood. Positive findings at radiologic study included a filling defect in the barium-filled ileum, suggesting intussusception. A barium enema examination showed a coarse, tubular filling defect with mucosal markings inside a segment of terminal ileum. The preoperative diagnosis was intussuscepting benign tumor of the small bowel. Surgery showed a Meckel's diverticulum, 3 cm. in length, inverted into the ileal lumen. An ulcer crater was present at the tip of the diverticulum.

"When a Meckel's diverticulum is suspected, clearly demonstrated, and finally surgically proved, the person responsible for the x-ray diagnosis usually cannot escape the feeling that the diagnosis came about through sheer luck or fortuitous circumstances which are not reproducible or predictable." The authors express the opinion that lesions of the ileum are more reliably and favorably demonstrated by retrograde filling as part of a barium enema study than by serial filming following barium ingestion.

The case is nicely illustrated by 5 small roentgenograms. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Gallstone Impacted in the Duodenal Bulb. David L. Berens. Gastroenterology **36:** 881–883, June 1959. (Lafayette General Hospital, Buffalo, N. Y.)

The occurrence of a gallstone remaining in the duodenal bulb following a cholecystoduodenal fistula is rare. Eight cases appear to have been reported in the literature, including the present one.

The roentgen diagnosis of cholecystoduodenal fistula with solitary calculus in the duodenal bulb and possible cancer of the stomach was confirmed by surgery.

Three roentgenograms.

ZOLTAN SZALONTAY, M.D.
Mercy Hospital, Pittsburgh

Visualization of the Biliary Tract. Preoperative, Operative and Postoperative Radiologic Investigation. C. Rollins Hanlon and C. Allen Wall. California Med. **90:** 422–425, June 1959. (St. Louis University, St. Louis 4, Mo.)

This paper is one of general interest, outlining the various investigative methods currently available for studying the biliary system, together with a discussion of media, indications, and reliability. Some points of interest include the following.

Oral Cholecystography: The authors believe there is value in having patients take some fat-containing food on the day preceding oral cholecystography in order to favor emptying of the gallbladder and refilling of the organ with bile containing the radiopaque agent. Patients who have been on a rigid fat-free diet for a long time "may fail to concentrate the radiopaque agent because it (the gallbladder) is already filled with inspissated bile at the time the contrast medium is ingested." Comment is made on the possibility of demonstrating radiolucent stones in both the gallbladder and the common duct by the layering of the cholecystographic medium in biliverdin at the periphery of the stone following repeated ingestion of the contrast agent for several days before the examination.

Intravenous Cholangiography: The main utility of intravenous cholangiography lies in the investigation of patients with persistent symptoms after cholecystectomy. The weakness of this test lies primarily in its inability to demonstrate the highly important lower end of the common duct in roughly 50 per cent of cases. With severe impairment of hepatic function or serum bilirubin levels above 5 mg. per cent, the chance of visualizing the common duct is very small. The authors also note that some of the newer oral contrast agents may demonstrate otherwise invisible radiolucent calculi that are missed with the intravenous method.

Operative Cholangiography: The authors are much impressed with the potential value of operative cholangiography in the demonstration of common duct stones at surgery. It is stressed that exploration of the common duct by manipulative methods and radiologic methods are complementary, not mutually exclusive. In the authors' own material, 8 per cent of an unstated number of patients who were judged by all other available methods to have extrahepatic biliary ducts free of stones were found by operative cholangiography to have one or more stones in the ducts.

Brief mention is made of blind percutaneous injection of radiopaque materials into the gallbladder or intrahepatic bile ducts. The writers consider this a dangerous and unwarranted practice.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Trial Study with a New Oral Cholecystographic Medium: Orabilex. E. F. Van Epps and F. M. Behlke. J. Iowa State M. Soc. **49:** 331–334, June 1959. (State University of Iowa College of Medicine, Iowa City, Iowa)

The new cholecystographic medium Orabilex was administered to 150 patients, all but 10 of whom had symptoms suggestive of gallbladder disease. None had clinical jaundice.

Good to excellent opacification of the gallbladder was obtained in 61.4 per cent of the cases. In 20 per cent of the series, gallstones were demonstrated. Of 89 patients given a fat meal, satisfactory gallbladder contraction was observed in 87.6 per cent, and in 39.3 per cent of this group the cystic and common ducts were visualized. In most instances there was no trace of the contrast material in the intestine during the routine radiographic examination. When present in the colon, the agent appeared as a faint radiopaque dispersion and did not interfere with film interpretation. The incidence of side-reactions was low.

Seven roentgenograms; 3 tables.

Orabilex: A New Cholecystocholangiographic Medium. Its Use in Visualizing the Nonvisualized Gallbladder and in Oral Cholangiography. Joseph P. Arcomano, James C. Barnett, and Lewis L. Immerman. Am. J. Digest. Dis. **4:** 466–478, June 1959. (North Shore Medical Group, Huntington, L. I., N. Y.)

Orabilex, a new cholecystocholangiographic medium, was used in 112 cases. No attempt was made to compare it with other cholecystographic media, but the authors believe that, despite the increased dose required, the new agent produces reliable gallbladder visualization with fewer side-reactions than other preparations.

Orabilex is absorbed by the small bowel into the portal circulation, where it is excreted by the liver with bile and finally concentrated in the gallbladder. There it can be seen about five hours following its ingestion; best visualization, however, is obtained after fourteen hours. The agent does not interfere with the contractility of the gallbladder following the ingestion of a motor fatty meal. Seventy per cent of the ingested Orabilex is excreted by the kidneys and 30 per cent by the gastrointestinal tract.

In a few instances visualization of the gallbladder was not obtained but, when nonvisualization occurred, surgery demonstrated the presence of disease.

In 2 cases in which routine doses did not permit visualization, 13.5 gm. of Orabilex and paregoric were employed. The common ducts were then distinctly outlined, but the gallbladder was not seen; surgery confirmed the radiologist's impression of obstruction in the cystic duct.

Attempts to visualize the common duct in the postcholecystectomy state with Orabilex achieved results comparable to those previously obtained with intravenous cholangiography.

Orabilex is never so concentrated within the gallbladder as to obscure disease. It has the excellent "look-through" quality that radiologists now favor in colloidal suspensions of other orally or rectally introduced contrast materials.

Thirteen roentgenograms; 1 table.

THE MUSCULOSKELETAL SYSTEM

Calvé's Disease: Does it Exist? The Question of Its Aetiology. I. Fényes and L. Zoltán. Brit. J. Radiol. **32:** 394–403, June 1959. (Institute for Neurosurgery, Budapest, Hungary)

The authors report the case of a boy of three and a half years with tuberculous spondylitis which produced a typical roentgen appearance of Calvé's disease (vertebra plana) in the body of D6. On the frontal view, a fusiform swelling was seen at D5, D6, and D7. Eventually, flaccid paralysis developed and a laminectomy was performed revealing granulation tissue extending into the D6-D7 intervertebral disk. Postoperative films showed a gradual partial regeneration of the involved vertebra, and films obtained four years later revealed a

typical appearance of healed tuberculous spondylitis. At that time the patient was asymptomatic and had no neurological defects.

The radiographic appearance of Calvé's disease has been observed by others in the following diseases: reticuloendotheliosis (including eosinophilic granuloma), sarcoma, carcinoma, neurofibromatosis, tetanus, multiple myeloma, osteomyelitis, rickets, syphilis, and trauma. Apparently, only a single case of so-called "true" Calvé's disease has been studied histologically (Mezzari, A.: Fortschr. a. d. Geb. d. Rontgenstrahlen: **57:** 275, 1938), and in this instance, the study was made in the phase of regeneration and syphilis was not excluded. In the authors' opinion, Calvé's disease is not a clinical entity and the radiographic appearance of vertebra plana may be due to any of several specific diseases.

Eight roentgenograms; 1 table.

SAMUEL B. HAVESON, M.D.
Lynwood, Calif.

Skeletal Changes in Sarcoidosis. Folke Knutsson. Acta radiol. **51:** 429–432, June 1959. (University Hospital, Uppsala, Sweden)

The author presents a concise and clear review of the bone lesions found in sarcoidosis. These lesions are: (1) single or multiple rounded areas of destruction in the epiphysis (so-called punched-out lesions); (2) more diffuse areas of cortical thinning and some medullary widening, with a honeycomb appearance; (3) the mutilating type.

A case is reported which had been followed for eighteen months. Structural changes in the phalanges of the third, fourth, and fifth fingers of the right hand gradually regressed in size and by the end of the observation period the trabecular pattern had returned almost to normal.

The author suggests that, since the bone lesions in sarcoidosis are of a temporary nature, it might be possible to detect more examples of bony change if repeated examinations of the hands and feet were made.

Six roentgenograms.

GEORGE C. BARRETT, M.D.
Bowman Gray School of Medicine

Bone Changes in Neurofibromatosis. Report of a Case with Coincidental Osteitis Deformans and Review of the Literature. Leslie J. Levene. Arch. Int. Med. **103:** 570–580, April 1959. (Cherry Knowle Hospital, Ryhope, Sunderland Co., Durham, England)

The author reports a case of neurofibromatosis complicated by coincidental osteitis deformans. The patient showed scoliosis, vertebral collapse, and cysts in the long bones. The changes of osteitis deformans were present in the skull, pelvis, and upper femurs.

Two references were found to Paget's disease of the bones complicating neurofibromatosis in the literature. Austregesilo and de Couto reported a case in 1930 (Encéphale **25:** 592, 1930) and Fairbank mentioned an example briefly in 1950 (J. Bone & Joint Surg. **32-B:** 266, 1950).

Three roentgenograms; 3 photographs.

THEODORE E. KEATS, M.D.
University of Missouri

Cockayne's Syndrome (Syn. Heredo-Familial Multi-Dystrophic Dwarfism). D. E. Copping. Proc. Coll. Radiologists Australasia **3:** 52–54, June 1959. (Princess Margaret Hospital, Perth, Western Australia)

The author reports 3 cases of Cockayne's syndrome in a family of five children in Western Australia. Only 5 cases have appeared previously in the world literature. In brief, the condition is characterized by dwarfism, lack of subcutaneous fat, and hypersensitivity of the skin to sunlight, defective hearing, arrested mental development, and a peculiar pigmented degeneration of the retina.

X-ray changes in the author's patients included broad, short metacarpals and phalanges, a thickened calvarium, and exaggerated epiphyseal notching of the anterior surfaces of the vertebral bodies.

Four roentgenograms; 1 photograph.

MAJ. MARTIN A. THOMAS, M.C.
MacDill AFB, Fla.

Idiopathic Hypoparathyroidism with Normal Urinary Calcium. L. Symon and Isobel M. Bett. Brit. M. J. **1:** 1451–1454, June 6, 1959. (Aberdeen Royal Infirmary, Aberdeen, Scotland)

The authors report the case of a twenty-one-year-old man with idiopathic hypoparathyroidism with a high normal daily calcium excretion in the urine and a history of convulsive episodes dating from early childhood.

Roentgenograms of the skull showed extensive irregular calcification in the basal ganglia of both sides and calcification in both dentate nuclei. There was also some hyperostosis of the frontal and parietal bones. The long bones, hands, chest, and abdomen showed no radiological abnormality. There was no subcutaneous or renal calcinosis. The teeth were poorly developed, many of them being mere stumps with evidence of apical infection. The lower incisors had particularly small roots. The trabeculae of the lumbar spine were prominent but there was no evidence of generalized increase in bone density.

The absence of stigmata of the peculiar syndrome of pseudohypoparathyroidism—short metacarpal bones, stunted stature, and soft-tissue calcification—together with the clinical history and the biochemical and roentgen findings were considered sufficient to justify a diagnosis of idiopathic hypoparathyroidism.

The normal or high level of calcium excretion in the urine and absence of other urinary abnormality, combined with the increase in urinary calcium excretion parallel with elevation of the serum calcium, suggest a disturbance of the renal threshold for calcium, an "idiopathic hypercalciuria." This is probably purely coincidental.

Six roentgenograms; 3 graphs.

Spondylolysis: Its Anatomy and Mechanism of Development. Hilel Nathan. J. Bone & Joint Surg. **41-A:** 303–320, March 1959. (Hebrew University-Hadassah Medical School, Jerusalem, Israel)

Nineteen instances of spondylolysis were found in a total of 450 skeletons from various anatomic collections. Approximately half of the skeletons were of individuals less than fifty years of age.

Typical spondylolysis was found in 16 skeletons. In most of these, the lesion was in the lower lumbar vertebrae, most frequently the fifth, and was usually bilateral; that is, the neural arch was separated on each side from the rest of the vertebra. The cleft of the isthmus was always located between the downward projecting inferior articular process of the vertebra above and the upward projecting superior articular process of

the vertebra below. Such clefts appear to be the result of compression of the isthmus by these articular processes in a mechanism termed a pincers effect. Preceding bone abnormalities or congenital defects of the isthmus would seem to be unnecessary for the production of the lesions.

The anatomical factors promoting the development of spondylolysis in some persons and those preventing its appearance in others are discussed. The participation of other factors, such as erect posture, trauma, age, sex, and race is also analyzed.

Skeletons were found in which the development of spondylolysis had ceased before total separation of the vertebral arch had occurred; marked depressions were present on the upper and lower surfaces of the isthmuses precisely at their sites of contact with the articular processes of the adjoining vertebrae. The term *prespondylolysis* is applied to these cases.

Two cases of spondylolysis were observed in which the clefts were not related to the articular processes of the adjoining vertebrae. These are referred to as *atypical spondylolysis*. In one case the first lumbar vertebra was affected, and in the other the second lumbar; in each instance, the cleft was on the right side only. It proceeded upward vertically from the lower border of the isthmus for about two-thirds of the way through the latter; it then turned medially through the entire width of the superior part of the lamina. The cleft may thus be said to have an inferolateral and a superomedial part; the former, located in the isthmus, was smooth, with the opposing faces resembling articular surfaces; the latter, passing through the lamina, was more irregular.

Typical and *atypical spondylolysis* was found in only 1 skeleton. The fifth lumbar vertebra showed bilateral clefts with all the characteristics and relationships of the typical case; the second lumbar displayed bilateral atypical clefts and the third lumbar a unilateral, atypical cleft on the right side.

No decision could be arrived at concerning the etiology of *atypical* spondylolysis. In *typical* spondylolysis, the thinning of the isthmus, the bone depressions or pits on the laminae, and the irregularities near the cleft, all intimately related to the articular processes of the vertebrae immediately above and below, can hardly have been produced other than by means of pressure exerted by these selfsame articular processes.

One roentgenogram; 12 photographs; 5 drawings; 5 tables.

The Normal Cervical Diskogram, with Clinical Observations. George W. Smith. Am. J. Roentgenol. **81**: 1006–1010, June 1959. (Eugene Talmadge Hospital, Augusta, Ga.)

Cervical diskography has been used by the author since 1952. The percutaneous approach with the needle directed through the anterior longitudinal ligament is described and illustrated.

Normal disk studies were done on younger individuals without cervical spine disease who came to autopsy. Relatively few normal cervical diskograms are obtained in patients beyond the age of twenty-five to thirty years.

A cervical diskogram differs from a lumbar diskogram. In the cervical area all of the injected medium is collected in one area in the center of the disk without the biloculation noted in the lumbar area.

The normal disk is extremely difficult to inject, requiring a great deal of forceful pressure. Injections achieved with slight pressure indicate degeneration or disease.

Cervical diskography has a number of disadvantages, which, however, are believed to be outweighed by its advantages. Among these latter are the following: It furnishes direct information regarding the disk and interspace, the point of rupture of the annulus fibrosus, and the direction of the extrusion. Definitive information can be gathered about the more laterally herniated disks and the minimal midline herniations which fail to distort the dural sac. The pain suffered by the patient is of brief duration and can be used to good advantage clinically, since it is often a precise reduplication of the type of pain which caused him to seek medical advice.

Five roentgenograms; 1 diagram.

JOSEPH P. TOMSULA, M.D.
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Vertebral Dislocation and Disc Herniation in the Lumbar Region. J. Wellauer. German M. Monthly **4**: 118–119, April 1959. (Röntgendiagnostische Zentralinstitut, Kantonsspital Zurich, Switzerland)

The occurrence of dorsal dislocation of any one of the lumbar vertebrae is described and related to the classical radiologic findings in the herniated disk syndrome. A bayonet-like picture is caused by deviation of the posterior surface of the affected vertebra from the normal curved contour. This may be visible anteriorly as well, and there is generally narrowing of the intervertebral foramina. A further roentgen sign is displacement of the intervertebral joint surfaces, with the spinous process of the dislocated vertebra being thrown into relief. The appearance of step-wise dislocation due to improper radiological technic may be recognized by the resulting double contour of the posterior vertebral surfaces.

Dorsal or dorsolateral rupture of the annulus fibrosus is the prerequisite and cause of dorsal dislocation, as it is of disk herniation. A total of 332 cases with 362 surgically proved disk herniations were reviewed. In 105, posterior vertebral dislocation could be seen on an ordinary film of the lumbar spine. In 72 cases there was complete correspondence between the levels of herniation and dislocation.

Posterior dislocation was not the only radiological change present in these cases of disk herniation. In the lower lumbar spine, especially at L-4 and L-5, narrowing of the disk space was a frequent finding. At higher lumbar levels proliferative change in the adjacent vertebral bodies was more prominent.

Of the 105 patients with posterior displacement, 61 had scoliosis. The convexity was toward the right in 28 and toward the left in 33. In 18, the level of the greatest curvature agreed with the site of displacement. Straightening, or even kyphosis, of the normal lumbar lordosis was found in 288 (81 per cent) of the 332 prolapsed disk cases. The presence of posterior dislocation aggravated this tendency.

Among 100 radiologic examinations of persons with "normal" lumbar spines, dorsal dislocation was incidentally discovered in 7: with an osteolytic vertebral body tumor (1 case), with severe diffuse osteoporosis and an old compression fracture (1 case), with tuberculous spondylitis (2 cases), and with no other vertebral lesions (3 cases).

One table.

Inflammatory Intervertebral Disc Disease as a Complication of the Operative Treatment of Lumbar Herniations. W. Eugene Stern and Paul H. Crandall. J. Neurosurg. **16:** 261–276, May 1959. (University of California Medical Center, Los Angeles, Calif.)

The authors describe inflammatory intervertebral disk disease as a complication of the operative treatment of lumbar herniations. Their experience is based on a series of 9 patients who suffered this complication. Each patient presented the syndrome of lumbar intervertebral disk herniation and at operation was shown (with a possible single exception) to have such herniation. In 3 patients there developed frank postoperative suppuration of the wound, 1 had a leptomeningitis, 1 suffered minimal drainage of the wound without demonstrable pathogen, and the remaining 4 had no drainage of the wound but complained of disabling lumbar pain of weeks or months duration. Extensive radiologic evidence of destruction of the adjacent vertebral bodies and obliteration of the intervertebral space with occasional solid bony fusion were seen postoperatively in all 9 cases.

The process was not revealed radiographically until two months after operation, at the earliest; and the roentgen appearance continued to change over a two-year period. The characteristic picture was a progressive irregularity of the adjacent articular surfaces followed by complete dissolution of the bony plate. Lytic areas, beginning anteriorly and continuous with the interspace, occurred, with sclerosis of the cancellous interior of the bodies, collapse of the interspace, and its eventual obliteration by calcification. An overall calcification of the bodies was also apparent, giving the appearance of a block of two narrowed bodies separated by a slit-like interspace or a complete block fusion. It was noted that the process, as observed radiographically, did not coincide with the degree of symptomatology, for progressive lysis about the interspace could occur in the presence of improving symptoms. No evidence of a paravertebral suppurative process was seen in any instance.

In the consideration of the etiologic factors, the frequent finding of a bacterial pathogen suggests this as the commonest cause. It is further suggested, however, that injurious mechanisms other than bacterial agents may cause an identical clinical and radiologic picture, not the least important of which may be a severe form of degenerative disease of the joint—a disease that permitted the herniation to occur in the first place.

The treatment of the chronic form of this syndrome is conservative. The morbidity is prolonged, but the ultimate prognosis is good.

Thirteen roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

THE SPINAL CORD

Spinal Cord Compression Produced by Extradural Malignant Tumours: Early Recognition, Treatment and Results. E. H. Botterell and G. W. FitzGerald. Canad. M. A. J. **80:** 791–796, May 15, 1959.

Seventy-five cases of spinal cord compression caused by verified epidural malignant tumors are analyzed. The series includes 29 malignant lymphomas and 13 myelomas, suggesting that these neoplasms together cause more cases of compression than secondary carcinomas. In 58 patients cord compression was the initial manifestation of malignant disease and in the majority this was the first indication of a serious illness. Pain due to nerve root compression was followed by progressive weakness of muscles, bladder and bowel disturbances, etc.

The diagnosis of root compression can usually be made by physical examination, but routine antero-posterior and lateral roentgenograms may give additional information. In approximately 50 per cent of cases due to carcinoma and myeloma, no abnormalities are demonstrable, and bony changes are even less frequent in the lymphoma group. In only 10 of the 29 malignant lymphomas was there disease of the spinal column. Of 10 cases of Hodgkin's disease, 6 showed radiological evidence of disease of the spine. In 11 myeloma cases, radiographs of the spine revealed collapse of vertebral bodies in 4. Roentgen evidence of secondary carcinoma of the vertebral column was present in 16 of 32 cases. The most frequent finding was destruction of vertebral bodies.

Myelography was performed to localize and indicate the extent of the epidural mass.

The best therapeutic results were obtained by surgical decompression followed by roentgen therapy and chemotherapy.

Five tables.

ZOLTAN SZALONTAY, M.D.
Mercy Hospital, Pittsburgh

Vascular Malformations of the Spinal Cord. Sidney W. Gross and Bruce L. Ralston. Surg., Gynec. & Obst. **108:** 673–678, June 1959. (Mount Sinai Hospital, New York, N. Y.)

The authors discuss 10 cases of vascular anomalies of the spinal cord seen between 1948 and 1957. Two theories of pathogenesis have been postulated: According to one, the origin is similar to that of varicose veins, *i.e.*, primary mechanical factors secondary to the erect posture are responsible; the other assumes a congenital origin.

Little is known about the make-up of the vascular malformations because angiograms are not usually obtained, and even at surgery the vessels are not handled because of fear of damage to the cord.

The authors point out that one must be careful not to confuse the dilatation and tortuosity of the vessels below an obstructing tumor with the primary malformations which usually exist in the presence of a freely open spinal cord.

Of the authors' 10 patients, 8 were males. The average age was 53.5 years (range fifteen to sixty-five years). Three had a history of sudden onset, while in 7 symptoms developed gradually, over a period of years. All had pain, but the earliest symptom was usually difficulty in the use of the legs. A few patients had sphincter signs. There was never a history of subarachnoid hemorrhage. All but one had some concomitant sensory disturbance. Two of the 10 had a complete block of the cord.

Myelography was done in all patients, and in 7 the appearance was characteristic, the defects being described as "tortuous," "circular," "cork-screw-like," "irregular," "branching," "serpiginous," and "bizarre." This picture was distinguishable from arachnoiditis, which usually shows an irregular structureless pattern.

The authors strongly recommend a full-column myelographic technic.

Results of treatment were not encouraging: 2 patients were improved, 5 slightly improved, 1 unchanged, 1 worse, and 1 dead. All were treated with laminectomy. No attempt was made to remove or coagulate the vessels because of possible cord damage. One patient received x-ray therapy with essentially no change in the course of the disease.

Almost all of the malformations were in the dorsal surface of the cord and were rarely above T-5. The adjacent arachnoid was usually thickened. One patient who died three days after operation was found postmortem to have bronchopneumonia, esophagitis, and gastritis with ulceration. There were large thin veins on the dorsum of the cord, extending into the posterior roots, and thick veins on the ventral surface.

Six roentgenograms; 1 photomicrograph; 4 photographs; 1 table.

MARK M. MISHKIN, M.D.
University of Pennsylvania

GYNECOLOGY AND OBSTETRICS

Hysterosalpingography with a New Water-Soluble Medium (Sinografin). C. Richard Weinberg. Surg., Gynec. & Obst. **108:** 679–682, June 1959. (The Harrison S. Martland Medical Center, Newark, N. J.)

The author reports on the use of Sinografin, an aqueous solution of the methylglucamine salts of diatrizoate and iodipamide, for the hysterosalpingographic examination of 50 patients, 32 of whom were investigated for problems of sterility and the remaining 18 because of signs or symptoms of other disorders referable to the female genitalia or pelvic viscera. Diatrizoate methylglucamine has been successfully used intravenously (Renografin, 60 per cent, 76 per cent, and 30 per cent), as has iodipamide methylglucamine (Cholografin methylglucamine, 52 per cent). Both have been shown, either when used separately or combined (Duografin), to be effective and safe radiopaque media. In Sinografin diatrizoate is present (as the acid) in 40 per cent concentration and iodipamide (as the acid) in 20 per cent concentration. The resulting mixture contains approximately 38 per cent iodine and has no viscosity additives.

The total amount of Sinografin, administered in the usual way through a cannula in the cervical canal, ranged from 5 to 10 c.c., the usual dose being 10 c.c. Except for minor cramping pain in 2 patients (one of whom had an intrabdominal pregnancy) no unpleasant side effects were encountered, and the films were entirely satisfactory with a single exception. The poor result in this case was attributable to the fact that the patient had a small cervical os and the medium spilled into the vagina instead of filling the uterine cavity.

It is concluded that Sinografin is a superior contrast agent, suitable for routine use in hysterosalpingography.

Five roentgenograms.

H. W. SCOTT, M.D.
University of Pennsylvania

Radiological Evaluation of the Pelvic Outlet. Lewis A. Gillanders. Brit. J. Radiol. **32:** 371–377, June 1959. (Selly Oak Hospital, Birmingham, England)

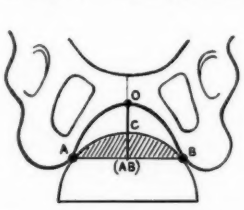
While it is commonly considered that outlet contraction is rare in the presence of satisfactory pelvic brim measurements, this is not always true. Clinical assessment of the outlet is generally regarded as sufficient, but radiological estimation may be requested if clinical examination suggests contraction. For this, a knowledge of normal and abnormal dimensions of the pelvic outlet is essential.

The author outlines various concepts of the pelvic outlet and methods of measurement. The two components of the pelvic arch of primary importance are (1) the distance from the pubic rami to the tip of the sacrum and (2) the shape of the subpubic arch. A narrow subpubic angle may be compensated by a long posterior pelvic diameter and, conversely, the favorable effect of wide subpubic angle can be minimized by a short posterior pelvic diameter. An arch of rounded shape, by allowing a more anterior position of the head, will be more favorable than one with the same subpubic angle but straighter descending rami.

The intertuberous measurement is taken as the transverse diameter of the outlet.

The author's method of outlet pelvimetry is outlined. The "final limiting points" of the pelvic outlet are taken to be (1) the sacral tip and (2) the "parietal touching points" (where the parietal bones of the fetal skull touch the descending rami).

These latter points are found by fitting a transparency of 103 mm. diameter into the subpubic arch. (A and B. Fig. 1). These points are then transferred onto the



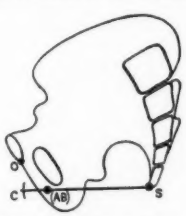


Fig. 1 (left). Tracing of outlet view, with transparent protractor in position.

Fig. 2 (right). Tracing of lateral radiograph, with plane of outlet represented by line (AB)S.

lateral film by measuring down the descending pubic rami the distance O(AB) after allowing for enlargement distortion. The line (AB)S in Figure 2 represents the plane in which the head "crowns." The shaded section of Figure 1 represents the portion of the head which can be accommodated in the anterior part of the pelvic outlet. This is indicated in Figure 2 by the line C (AB). The anteroposterior diameter of the outlet available is now CS and can be easily found by adding the measurement of C(AB) obtained from the outlet film to that of (AB)S from the lateral film. In theory, the critical figure should be somewhere in the region of 9.5 cm. In practice, this figure is subtracted from the corrected measurement obtained from the films, and the difference is termed the "free space of the outlet." If this "free space" is of any magnitude, no difficulty is to be expected; if it is less than zero, disproportion is present.

A study of 62 consecutive cases, for which details are tabulated, indicates the reliability of this method.

One roentgenogram; 3 drawings; 1 graph.

RICHARD P. STORRS, M.D.
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THE GENITOURINARY SYSTEM

A Clinical Evaluation of the Iodopyracet (Diodrast) Renogram. Maria Serratto, John T. Grayhack, and David P. Earle. Arch. Int. Med. **103:** 851–858, June 1959. (Northwestern University Medical School, Chicago 11, Ill.)

The authors have found the radioactive iodopyracet renogram a safe and simple means of clinical evaluation of a number of renal and urinary tract diseases, especially those characterized by obstruction.

The patient is examined in the upright position with scintillation counters placed above each kidney and directed along the long axis of the organ. Iodopyracet labeled with I^{131} is injected intravenously 1 μc per 5 kg. of body weight. The radioactivity in the renal areas is then recorded for fifteen to thirty minutes. Four distinct phases may be seen in the normal renogram: (1) A rapid initial upswing reflects the blood supply to the kidneys and adjacent tissues. (2) During the next three to five minutes a further gradual increase in renal radioactivity is noted (accumulation phase). (3) The clearance or excretory phase follows, with a gradual disappearance of radioactivity for ten to fifteen minutes. The latter two phases probably reflect concentration of the iodopyracet by the renal tubules, followed by its secretion into the urinary collecting system. (4) Finally, a stage of equilibrium is reached which represents residual activity not only from the kidneys, but also from elsewhere, including the bladder urine.

Bilateral renograms are useful in detecting unilateral renal disease and can be used for this purpose in screening patients with hypertension. They are a more sensitive indicator of renal abnormality than are intravenous urograms. The latter, however, obviously can furnish information not available on renograms.

Renograms can also reveal quantitative evidence of functional impairment, but generally are not as sensitive for this purpose as are the usual renal function tests.

Illustrative cases are reported.

Nine figures; 5 tables.

THEODORE E. KEATS, M.D.
University of Missouri

The Use of Chlor-Trimeton with Miokon in Intravenous Urography. Owen W. Doyle. J. Urol. **81:** 573–574, April 1959. (1013 Professional Village, Greensboro, N. C.)

In the performance of urography, the author attempted to reduce the incidence and severity of reactions to the medium—Miokon 50 per cent—by the addition of 1.0 c.c. of the antihistamine Chlor-Trimeton. Results in 400 pyelographic studies with this combination were compared with a control series of 150 injections of Miokon alone.

In both series, reactions included nausea, vomiting, vasomotor effects, arm pain, urticaria, and sneezing. By addition of the antihistamine, however, the incidence and severity of the side-effects were significantly diminished. The total frequency of reactions averaged 20.6 per cent with Miokon alone and 10.5 per cent with Miokon and Chlor-Trimeton.

One table.

DAVID E. KUHL, M.D.
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Arteriovenous Fistula of the Kidney: New Observations and Report of Three Cases. Charles H. Scheifley, Guy W. Daugherty, Laurence F. Greene, and James T. Priestley. Circulation **19:** 662–671, May 1959. (Mayo Clinic, Rochester, Minn.)

Abnormal arteriovenous communications in the kidney and renal vessels may be congenital, traumatic, or the result of a malignant tumor. The traumatic cases may be due to penetrating injuries or may follow a surgical procedure involving the renal vessels. There is evidence to support the thesis that the congenital fistulas may be produced by erosion of a renal arterial aneurysm into the vein.

The most notable clinical features are hypertension and cardiac enlargement, with varying degrees of myocardial insufficiency. The overloading of the circulation because of high cardiac output is characteristic of arteriovenous fistulas from the renal as well as from the peripheral vessels. There are several reasons for the cardiac enlargement and heart failure. The pressure, as well as the pulsatile character of the arterial blood in the renal artery distal to the fistula, is decreased, and with it the rate of flow to the kidney. This gives an effect similar to that seen in a "Goldblatt kidney," and hypertension almost invariably results.

The chest film reveals nonspecific cardiac enlargement, basal congestion, and elevation of the diaphragm from congestive failure. Pyelography should show diminution or absence of function and possibly distortion by an extrinsic mass (the aneurysm or tumor if that is the cause). Aortography or angiography will demonstrate the fistula itself.

Of the author's cases, one resulted from a penetrating wound, one from a hypernephroma, and one probably from erosion of an aneurysm.

Five roentgenograms; 2 diagrams; 1 chart; 2 tables.

ZAC F. ENDRESS, M.D.
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Renal Function in Congenital Bladder Neck Obstruction. Jan Winberg. Acta chir. scandinav. **116:** 332–344, 1959. (Department of Pediatrics, Karolinska Sjukhuset, Stockholm, Sweden)

Bladder neck obstruction is defined as a narrowing and deficient relaxation of the bladder neck during micturition. The clinical and roentgenologic findings in 5 infants under nine months of age with congenital bladder neck obstruction are described. Attention was called to the malformation by acute infections. Clinically these infections were, in most instances, not more severe than pyelonephritis without obstruction. Bilateral hydronephrosis was found in 4 cases; in the fifth, the roentgen appearance of the urinary tract was normal. Vesicoureteral reflux was also present in 4 cases. Resection of the bladder neck was performed in each instance. At postoperative examination, the hydronephrosis had diminished in 1 case and was probably unchanged in another. Postoperative urography had not yet been performed in the other 3 cases.

In spite of the good general condition of these patients, there was already decreased renal function after the first or second acute infection. It is believed that the acute infections were chiefly responsible for the renal damage, but proof is not given of this opinion. The changes in renal function were, as a rule, reversible but persisted in 1 case for as long as fifteen months after surgery.

This investigation emphasizes the necessity of early diagnosis and surgical intervention to establish good drainage of the urinary tract. Diagnosis is based upon

micturition cystourethrograms with frontal and true lateral projections plus endoscopy (see, for example, Kjellberg, Ericsson, and Rudhe: The Lower Urinary Tract in Childhood. Almqvist & Wiksell, Uppsala, 1957). Endoscopy alone has not proved sufficient for diagnosis. Residual urine is difficult to judge in infants, especially if there is vesico-ureteral reflux.

Eight roentgenograms; 1 graph; 4 tables.

Implantation Metastasis in Renal Pelvis from Primary Tumours of Bladder. Arne E. Nilson. Acta chir. scandinav. **116:** 306–314, 1959. (Department of Diagnostic Roentgenology, Karolinska Sjukhuset, Stockholm, Sweden)

Five cases of recurrent fibroepithelioma of the urinary bladder with secondary tumor of the renal pelvis are reported; these cases demonstrate that intracanalicular implantation metastasis may occur from the bladder to the kidney pelvis.

If implantation metastasis is to qualify as the most likely mode of origin of subsequent tumors of the renal pelvis, certain pathological requirements must be fulfilled: (1) The malignancy of the supposed mother tumor must be Grade 2 to 5. All of the author's cases fulfilled this requirement. (2) The degree of malignancy of the secondary tumor of the renal pelvis must be equal to, or one or two grades above, that of the original tumor of the bladder. One patient in the present series did not undergo surgery; in the other 4 cases the relationship between the primary tumor and the subsequent tumor of the renal pelvis was established. (3) The ureter between the tumors should be microscopically free of tumor cells that display infiltrative growth into the walls or the blood vessels and lymphatics. In the 4 cases undergoing nephrectomy, this requirement was fulfilled. (4) In the mucosa of the renal pelvis and ureter there should be no local microscopic changes suggestive of tumor "germs" [deposits?]. In 1 case cystic formations were observed in the epithelium of the renal pelvic tumor, and the surrounding mucosa displayed features reminiscent of pyelitis cystica. Further distally in the renal pelvis was a well defined region in which varying stages of this condition were represented, but no actual papillomas were perceptible. It was possible, however, to discern a gradual transition from these pyelitis cystica areas to the papillomas. It is most likely that in this case the tumors of the renal pelvis developed from multiple primary growths subsequent to the occurrence of pyelitis cystica. Nevertheless, one cannot rule out the possibility of implantation in the region possibly predisposed by the pyelitis cystica. The requirement was fulfilled in the other 3 cases in which nephrectomy was performed.

In 3 cases a urethral catheter was introduced and retrograde pyelography was carried out on the involved side to verify the diagnosis of pelvic tumor. The excretion of the affected kidney had ceased in 1 case and was lowered in the other 2. In no instance had ureteral catheterization preceded the discovery of the renal pelvic tumor. Vesico-ureteral reflux was detected prior to or at the same time as the renal pelvic tumor, three to eight years after treatment of the initial bladder tumor. There was, however, no continuous cystographic check on the reflux and the exact time of its onset is therefore unknown. Cystoscopy revealed appreciable anatomic changes of all the ureteral orifices at which cystography disclosed reflux. In 1 case, although both ureteral orifices appeared patent on inspection, reflux was observed on only one side. There was, then, no definite correlation between the cystoscopic appearance of the ureteral orifices and their valvular function. In 1 case with bilateral ureteral reflux and cystoscopic changes of both orifices, a renal pelvic tumor was found on only one side.

Valvular incompetence is essential for the transport of tumor cells from the bladder to the renal pelvis. In all 5 cases a number of surgical procedures in the vicinity of a ureteral orifice, in some instances accompanied by radiotherapy, may have led to local inflammation of adjacent tissue resulting in fibrosis of the bladder wall. This may have produced rigidity around the intramural segment of the ureter and subsequent dysfunction of the sensitive valvular mechanism. In 1 case a further cause of dysfunction was reimplantation of the ureter. In every instance recurrent infection of the urinary tract may have contributed to the chronic inflammatory conversion.

Defective valvular function should be borne in mind since surgery for bladder tumors situated in the vicinity of the ureteral orifices—a common site—may well damage the valvular mechanism and thereby create the conditions permitting ureteral reflux. After operations for bladder tumor near the ureteral orifice, cystographic watch should be kept for the occurrence of reflux; the functional state of the valvular mechanism cannot be ascertained by cystoscopy. When vesico-ureteral reflux is demonstrated, frequent urographic examinations should be made to detect implantation metastasis. Catheterization should be practiced with restraint in all cases of bladder tumor in which reflux has been found, so long as urography has not shown complete inhibition of excretion.

Seventeen roentgenograms; 9 photomicrographs; 2 drawings; 1 photograph.

Ureterocele in Adults. Clinical and Roentgenographic Follow Up. Trygve N. Aas and Arne E. Nilson. Acta chir. scandinav. **116:** 263–267, 1959. (Karolinska Sjukhuset, Stockholm, Sweden)

The results of follow-up examination in 18 patients with 25 ureteroceles ranging in size up to that of a walnut are presented. Fifteen ureteroceles occurred in 11 women, and 10 in 7 men. Eleven of the cysts were unilateral, 6 on the left and 5 on the right side. A stone was present in a unilateral cyst in 7 patients, 3 of whom had bilateral ureterocele. The interval elapsing before follow-up was more than ten years in 3 patients, between five and ten years in 8, between two and five years in 6, and nine months in 1. Cystoscopy was performed in 17 patients, and cystography and urography in 18.

In no instance had the ureterocele led to any decrease in kidney function demonstrable urographically. Thirteen ureteroceles treated conservatively were found to have been stationary during the interval, with the size of the ureterocele and ureteral drainage unchanged. Among the 12 ureteroceles (7 with stone) treated surgically, one recurrence and one instance of vesico-ureteral reflux were discovered. In the cases with impeded drainage attributable to the ureterocele, drainage had improved or normalized. The authors conclude that surgical intervention for ureteroceles up to the size of a walnut is indicated only when the condition is complicated, as by recurrent infection or stone.

Eight roentgenograms.

MISCELLANEOUS

Idiopathic Hypercalcemia. Donald Gribetz and Bernard S. Wolf. Am. J. Med. **26:** 936–944, June 1959. (Mt. Sinai Hospital, New York 29, N. Y.)

There are at least two varieties of idiopathic hypercalcemia: a chronic, severe form and a transitory, mild type. The severe form has been described as consisting of the triad of (1) hypercalcemia associated with azotemia, (2) osteosclerosis, and (3) physical and mental retardation. Patients with this type of disease usually pursue a progressively downhill course, and a "sizable number" succumb within the first five years of life. The milder variety is characterized by an elevated serum calcium accompanied by the symptoms usually associated with hypercalcemia, *i.e.*, anorexia, vomiting, constipation, polyuria, and muscular hypotonia: this form is not accompanied by osseous changes or physical or mental retardation, and there is a tendency toward spontaneous remission after several months.

The authors analyze 25 previously recorded cases of the severe type of idiopathic hypercalcemia and report a case which apparently represents an intermediate form of the syndrome. Their patient was first seen at the age of ten and a half years and has been under observation for four years. During this time hypercalcemia and azotemia have been present, and unusual changes in the skeleton have been demonstrated roentgenographically. The patient, however, is not mentally or physically retarded; he appears to be the oldest person thus far encountered with the syndrome of idiopathic hypercalcemia.

The etiology and treatment of idiopathic hypercalcemia are discussed.

Nine roentgenograms; 1 photograph; 2 charts; 2 tables.

Tuberous Sclerosis: Case Record and Discussion. Victor Berman and Edwin Myer. South African M. J. **33:** 181–183, Feb. 28, 1959. (Transvaal Memorial Hospital for Children, Johannesburg, Union of South Africa)

A case of tuberous sclerosis in an eleven-year-old boy is reported. This patient was admitted to the hospital with adenoma sebaceum of the face associated with mental retardation and fits. Roentgenologic findings included intracranial calcification adjacent to the lateral ventricles. This feature was found in 50 per cent of the 43 cases recorded by Holt and Dickerson (Radiology **58:** 1, 1952). Roentgenograms of the hands showed a small cystic area with clear-cut margins in the tuft of the terminal phalanx of the left third finger; similar but less clearly defined cystic areas were seen in the terminal phalanges of the right index and fourth fingers. Holt and Dickerson state that 66 per cent of 30 patients who had x-ray studies of the hands and feet exhibited local cystic lesions in the phalanges with or without periosteal formation of new bone in the metacarpals or metatarsals. The wavy periosteal reaction in the phalanges described as being characteristic of tuberous sclerosis was not demonstrable in the present case.

Five roentgenograms: 2 photographs.

The Plain Film Survey of the Abdomen. I. Patricia Waugh. M. J. Australia **1:** 866–867, June 27, 1959. (Parramatta, N. S. W., Australia).

The following statement was made by Sir James McKenzie Davidson in 1902: "The abdomen is very difficult to examine by x-rays. With the exception of gaseous distension of the stomach, renal calculi and metallic foreign bodies, little information can be obtained." Obviously, this is no longer true. Although interpretation may still be difficult, a great deal of valuable information may be obtained by this relatively simple and cheap diagnostic method.

In a routine survey of the abdomen, one studies the outline of the kidneys, liver, and spleen, the psoas muscles, the flanks, and the diaphragm. Any calcification present should be noted and the gas patterns studied. The films to be taken will be decided upon after reference to the clinical notes, or after the taking of a preliminary supine view.

The author discusses pathological findings under the following headings: calcification, soft-tissue tumors, collections of fluid, abnormal gas patterns, traumatic lesions, foreign bodies. In some cases, the findings are diagnostic. In others, *e.g.*, in acute abdominal emergencies, the taking of the plain film is the only radiological investigation permitted because of the patient's condition. At all times, close co-operation between the radiologist and clinician is essential. A personal discussion helps toward a better understanding of the mutual problems.

Eight roentgenograms. SHAWKI ASMAR, M.D.
Cleveland Metropolitan General Hospital

RADIOTHERAPY

Malignant Disease of the Head and Neck in Childhood. Harry W. Southwick, Danely P. Slaughter, and James D. Majarakis. Arch. Surg. **78:** 678–687, May 1959. (30 N. Michigan Ave., Chicago, Ill.)

The authors review 70 cases of malignant disease of children occurring in the head and neck, encountered over a fifteen-year period. Intracranial tumors and retinoblastomas are excluded. Sarcomas numbered 48, with malignant lymphoma accounting for about half of these. There were 8 instances of fibrosarcoma, 4 of neurofibrosarcoma, and lesser numbers of other types. Children with lymphomatous tumors were managed with various combinations of surgical and radiotherapeutic procedures. Fibrosarcoma was treated predominantly by surgical excision, as was neurofibrosarcoma. The authors stress the relatively favorable prognosis in fibrosarcoma: in their series of 8 cases, there were 6 survivals for three years or more, 3 over five years.

Carcinomas tend to develop in the later years of childhood, and no patient in this series was under the age of five. Fourteen of the 22 carcinomas occurred in the thyroid gland: 9 were papillary adenocarcinomas and 5 were follicular adenocarcinomas. Thyroidectomy in conjunction with radical neck dissection and bilateral paratracheal node resection is the treatment of choice for the papillary lesions "with or without clinical evidence of metastatic disease." Ten of the 14 children in this group had had previous external irradiation to the head and neck area! All 14 were

alive at the time of this report although two had evidence of metastatic disease four and seven years after the establishment of diagnosis. Four patients had malignant lesions of the salivary glands. All were treated by surgical excision and all had survived.

In conclusion, the authors note the expected preponderance of sarcomas over carcinomas in this age group. They point out that malignant disease results in more deaths in the four- to fifteen-year-old group than any other single cause except accidents. It is also noted that the outlook is not so hopeless as is generally thought, particularly in the case of adequately treated fibrosarcoma and neurofibrosarcoma.

Two photomicrographs; 5 photographs; 1 diagram; 5 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Glomus Jugulare Tumor. A Report of Two Cases. David Myers and Eugene N. Myers. Arch. Otolaryng. **69:** 732–736, June 1959. (3701 N. Broad St., Philadelphia 40, Penna).

Two cases of glomus jugulare tumor are reported and contrasted as to their diagnosis and treatment. A right complete mastoidectomy was performed in the first patient, a twenty-nine-year-old woman, in 1951. At that time the patient complained of a pulsation in the right ear of nine years duration, and there was a severe conductive loss in that ear. In 1957, the patient was again seen, complaining of a return of her otitis and a feeling of numbness of the face. A complete right peripheral facial paralysis was present. Examination showed a large polyp completely filling the right external auditory canal. Roentgenography revealed destruction of the petrous apex, which had extended laterally to the labyrinthine structures. There was also osseous destruction in the region of the carotid canal, in the internal auditory meatus, and in the jugular fossa. Clinical and x-ray findings were thought to be due to a recurrence of the mastoiditis and extension of a cholesteatoma. A radical mastoidectomy was performed. A great deal of bleeding was encountered, and the mastoid cavity was found to contain a hemorrhagic mass of tissue which bled freely. The operation was completed by removal of the posterior canal wall, whereupon the middle ear was seen to be filled with a large polyp, which presented through the internal auditory meatus. When the polyp was evulsed from the middle ear, severe bleeding occurred. It was noted that the entire bony medial wall of the middle ear was no longer palpable, and tumor tissue filled the region of the petrous apex. Further tissue was removed which extended as far forward as the internal carotid artery. The true nature of the tumor was recognized, the internal carotid artery was ligated, and the tumor cavity packed. About two weeks later under general anesthesia the packing was removed. No further bleeding took place. A graft from the right gastrocnemius muscle was inserted into the tumor cavity, and the cavity repacked. Over the next ten days, 1,200 r x-ray therapy was administered. After discharge from the hospital, additional irradiation was given for a total of 5,000 r. The facial paralysis has cleared, and the patient has remained in good health.

The second patient, a thirty-nine-year-old man, was admitted to the hospital with a diagnosis of mastoiditis. A polyp had been removed from the left ear nine years previously, but a biopsy had not been performed. Examination showed a large polyp extruding from the left external auditory meatus and a large mass in the left nasopharynx. On biopsy, the polyp bled freely. The tissue was reported by the pathologist to be "chronic inflammatory polyp." Examination also showed tinnitus and a severe conductive loss on the left, with some limitation of eye movement bilaterally; decreased sensation on the left side of the face; complete paralysis of the left side of the soft palate; and deviation of the tongue to the left. Roentgenography revealed considerable bony destruction of the left petrous apex as well as of the base of the skull, also cloudiness of the mastoid air cells. The radiologist considered these findings suggestive of nonchromaffin paraganglioma (glomus jugulare tumor).

Because of the diffuse neurological symptoms and extensive erosion demonstrated roentgenologically, the patient was thought to be a poor candidate for surgery, and x-ray therapy was begun. During this treatment, the condition gradually improved and the patient was discharged from the hospital after receiving a total of 3,700 r to the tumor site. He was re-admitted about three weeks later, and a suboccipital craniotomy and bilateral laminectomy of the atlas were performed. Although some improvement followed this procedure, the condition was deteriorating rapidly at the time of this report.

The authors mention the need for further appraisal of x-ray and surgical therapy by follow-up of larger series of cases, over longer periods of time.

Four roentgenograms.

Restoration of the Sella Turcica After Treatment of Pituitary Adenomas. Sol M. Unger and Bernard Roswit. Am. J. Roentgenol. **81:** 967–971, June 1959. (VA Hospital, Bronx 68, N. Y.)

The authors describe 3 cases out of 70 treated for pituitary adenomas in which there was evidence of sellar reconstitution. In 2 of these there was shrinking of the sella as well as recalcification of its structures.

Case I: A chromophobe adenoma was treated by surgery and radiation (3,000 r). In three months roentgen examination demonstrated recalcification and reduction in size of the enlarged sella.

Case II: A chromophobe adenoma was treated by surgery and x-rays (2,900 r). In a year recalcification and shrinking were demonstrable.

Case III: An eosinophilic adenoma was treated by x-rays (3,000 r). In three years recalcification and reconstitution of the dorsum sellae and posterior clinoids were shown roentgenologically.

A fourth case with post-irradiation calcification and shrinkage of the ballooned sella was previously reported from the same institution (Adler and Kaplan: Radiology **66:** 856, 1956)

Seven roentgenograms; 6 diagrams.

PAUL MASSIK, M.D.
Quincy, Mass.

Carcinoma of the Nasopharynx: An Analysis of Thirty-Four Cases and a Preliminary Report on Palatal Fenestration in Its Management. L. Q. Pang. Ann. Otol., Rhin. & Laryng. **68:** 356–371, June 1959. (1374 Nuuanu Ave., Honolulu, Hawaii)

Carcinoma of the nasopharynx is the most malignant of all tumors of the upper respiratory and alimentary tracts and one that is most frequently missed in its early stages. An analysis of a series of 34 cases with a preliminary report on the author's experiences with

palatal fenestration in the management of these cases is presented.

The reported incidence of carcinoma of the nasopharynx varies with different authors. It has been estimated that it makes up from 1 to 3 per cent of all malignant growths. It is a well known fact that the Chinese are especially susceptible to this disease.

The average age in the present series was forty-four years. The youngest patient was twenty-five and the oldest sixty-seven years of age. Seven (21 per cent) were below the age of thirty. Twenty-seven were Chinese.

The predominating symptoms in the order of frequency were enlarged cervical nodes, unilateral nasal obstruction, bloody nasal discharge, hissing tinnitus, a feeling of blockage in the ear, impaired hearing, and head and neck pains.

Lymph node metastases occurred in 22 cases (65 per cent). The nodes most frequently involved were those below the angle of the jaw and those beneath the upper attachment of the sternomastoid muscle. Intracranial metastases were present in 16 cases (47 per cent). Of this number less than half showed radiologic evidence of destruction of the base of the skull.

Distant metastases occur more frequently than with any other malignant lesion of the upper respiratory and alimentary tracts. In this series, they developed in 7 cases.

Early diagnosis of nasopharyngeal tumors depends upon (1) a high degree of suspicion; (2) a careful examination and visualization of the entire nasopharynx of any patient presenting the symptoms enumerated above; (3) biopsy of any suspected lesion. Most of the lesions can be visualized with the nasopharyngeal mirror or nasopharyngoscope. A roentgenogram of the base of the skull is recommended in cases where intracranial extension is suspected. Biopsy should be repeated as long as there is any suspicion of malignancy. In one of the author's cases, four biopsies were necessary to prove the diagnosis.

Histopathologically, transitional-cell carcinoma accounted for more than 50 per cent of the cases. The next in frequency was the lympho-epithelioma, or so-called Schmincke tumor.

The universal treatment is irradiation. In all these cases, deep x-ray therapy was used. Under radiotherapy, the lesions in the nasopharynx and the cervical nodes virtually melt away, but unfortunately, while the lesions are radiosensitive, they are not radiocurable. A recurrence of the local lesions developed in over 50 per cent of the author's series of cases. The lesion became progressively more radioresistant with each recurrence.

No unanimity of opinion exists regarding the management of the cervical metastases. It would seem to be the majority opinion that irradiation is capable of permanently controlling a fair percentage of these. The author believes a neck dissection to be of benefit only in those cases where the primary lesion is definitely controlled by the irradiation. Carcinoma of the nasopharynx carries a high mortality. In this series 22 patients died of the disease. The average length of life in these cases was twenty-nine months. There were 6 five-year survivals. However, 2 of these patients died eventually from recurrences and intracranial metastases. Eight cases had been followed for less than four years.

In the irradiation of the nasopharynx, the chief difficulty is the inability of the radiotherapist to visualize the lesion clearly and thus accurately determine its size and extent. He is unable to check the accuracy of the beam and the measurement of the dosage, and to observe the effect of the irradiation upon the tumor during the treatment. Palatal fenestration (Wilson: Ann. Otol., Rhin. & Laryng. **66:** 5, 1957) is of aid in this situation. The basic principle consists of splitting away the soft palate from the hard palate and removing a sufficient portion of the hard palate and the vomer to create a fenestra that enables one to look directly into the nasopharynx. This fenestra is permanent and is easily covered with a dental prosthesis inserted as soon as the patient reacts from the anesthesia.

To date, 4 cases have been treated by this method. At the time of surgery, the lesion is electrodesiccated and a 25-mg. radium capsule is inserted and held in place by a Foley catheter. A total dosage of 500 mg. hours is given. Subsequently, deep x-ray therapy is carried out. While this series is small, the advantages of the procedure are obvious.

Two tables.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Surgery of the Neck Following Radiation Therapy for Cancer. Walter P. Work. Ann. Otol., Rhin., and Laryng. **68:** 393–410, June 1959. (384 Post St., San Francisco, Calif.)

The purpose of this paper is to present the author's surgical experiences in 22 cases in which x-ray therapy was the initial treatment for primary carcinoma of the larynx or pharynx. In all cases the irradiation was reportedly given in tumor doses considered adequate for arresting the disease. Surgery was performed for unarrested cancer or for adverse tissue reactions from the irradiation.

All the patients were males between the ages of thirty-six and seventy-two years. Nineteen of the group had primary disease of the larynx while the remaining 3 had primary disease of the pharynx. In 11 cases, the primary lesions were cordal, stage I or early stage II, which means that they were ideal for radiation therapy. Of the remaining 11 tumors, 5 were supraglottic (questionable stage) and 3 were pharyngeal (advanced inoperable). In 3 patients, the exact site of the primary laryngeal lesion was not clear from the records.

The cases are classified as follows:

Laryngeal Cancer

Group I. Cancer not controlled by x-ray therapy.
1. Early cases, nonarrested or recurrence.
2. Late cases, nonarrested or recurrence.

Group II. Cancer controlled by x-ray therapy; however, complications developed from irradiation.
1. Early complications.
2. Late complications.

Pharyngeal Cancer

Group III. Primary cancer partially or fully arrested by irradiation.

Wide-field laryngectomy was the definitive operation carried out in patients in Groups I and II. Block dissections of the neck were done when indicated, either combined with laryngectomy or at a later date. Plastic operations were performed in some cases in multiple steps after laryngectomy, while full thickness sliding skin grafts were used at the initial operation in others. For the Group III patients the type of surgery varied.

In Groups I, II, and III there are 15 patients living and well from five months to nine years postsurgery. Three patients died of other causes, one to three years after operation, while the remaining 4 died of cancer.

The author concludes that surgery of the neck in patients following x-ray therapy for unarrested primary squamous-cell carcinoma of the larynx can usually be done within the first year following radiation therapy without surgical technical difficulties and without undue complications in healing. There are exceptional cases, however, with "early" radiation changes (*i.e.*, in the first year) that may present many problems, not only in the performance of surgery but in healing. Some of the patients in this series had varying degrees of perichondritis of the laryngeal cartilage and were seriously ill in spite of apparently arrested cancer.

Eight photographs. STEPHEN N. TAGER, M.D.
Evansville, Ind.

Spinal Cord Tumors in Children. Harold Haft, Joseph Ransohoff, and Sidney Carter. Pediatrics **23:** 1152–1159, June 1959. (S. C., 622 West 168th St., New York 32, N. Y.)

The case histories of 30 children (fifteen years of age or younger) with spinal cord tumors, seen at the New York Neurological Institute and Babies Hospital of the Columbia-Presbyterian Medical Center (New York) were reviewed. Age and sex distribution were not significant. The most frequent site of involvement was between the seventh cervical and the fifth lumbar vertebra. Fifteen of the tumors were extradural and 15 were intradural; in the latter group 10 were intramedullary and 5 extramedullary. Neuroblastomas, ganglioneuromas, and sarcomas, resulting from extension of paraspinal lesions, were the predominant extradural masses. The intramedullary tumors were found to be either astrocytomas or ependymomas, when histologic identification was possible. The extramedullary intradural tumors were the more benign lesions, consisting of 3 epidermoids, 1 meningioma, and 1 neurofibroma.

The duration of symptoms prior to hospitalization ranged from two weeks to six years, with an average of one and a half years. Abnormality of gait and posture was present in 24 of the 30 cases and pain in 20. Leg weakness and abnormal reflexes occurred in 23 cases and sensory deficit in 16.

Plain roentgenograms of the spine were made in 27 of the 30 children and were of aid in establishing the diagnosis in 19. Erosions and deformities of the vertebral body were demonstrated in 11 patients; erosion and asymmetry of the pedicle in 8; increased interpedicular spaces and scoliosis in 3 cases each; and decreased cervical lordosis and a widened intervertebral foramen in 1 patient each. Chest roentgenograms revealed metastatic lesions in the pulmonary parenchyma in 9 patients and rib erosion in 4. Myelography was performed in 15 patients and was diagnostic in all. Lumbar puncture was done in 19 cases; it indicated a complete block in 7 cases; 4 patients had definite xanthochromia of the cerebrospinal fluid.

Treatment consisted of surgical excision and irradiation. Excision of the entire tumor was accomplished in 2 of the 10 patients with intramedullary tumors in this series. In the remaining 20, with extradural or intradural extramedullary tumors, a decompressive laminectomy was performed and as much tumor as possible was removed. Total removal was achieved in 5 cases in this group. X-ray therapy was delivered to the spine in 20 cases and to lesions in the chest in 4.

Ten patients were followed until death, for periods ranging from one month to three years postoperatively. One patient was lost sight of after discharge eleven years ago, and 2 were lost after five and six years of follow-up. Of the remaining 17 patients, seen in 1957, 14 are improved and 3 are unchanged. Kyphosis developed in 10, but only 1 required spinal fusion. Of the 10 patients who died, all but 1 had received x-ray therapy and were unimproved to death; intracranial signs and symptoms developed in 3. All 3 unimproved living patients received radiation therapy.

Two illustrative cases are reported.

Two figures; 5 tables.

Neuroblastoma Sympatheticum. A Study and Report of 217 Cases. Robert E. Gross, Sidney Farber, and Lester W. Martin. Pediatrics **23:** 1179–1191, June 1959. (R. E. G., 300 Longwood Ave., Boston 15, Mass.)

Two hundred and seventeen cases of neuroblastoma seen at the Children's Hospital, Boston, between January 1920 and January 1957, were reviewed to determine factors influencing prognosis and to evaluate the various types of therapy.

Neuroblastoma is a tumor of early life. Seventy-six per cent of the patients in the present series were under five years of age, the youngest being four hours and the oldest sixteen years. In 70 per cent of the cases there were metastases at the time of initial hospitalization and study. In 40 per cent of all cases, the tumor arose in the adrenal gland; in 11 per cent, in paravertebral tissues in the thorax; in 5 per cent, from the retroperitoneal sympathetic chain; in 6 per cent, from the pelvic nerves; in 2 per cent, from the neck. In some instances the site of the tumor could not be identified because the lesion was so widely disseminated throughout the body at the time the child was first seen or a necropsy was performed.

Treatment of patients with neuroblastoma does not lie solely in the province of a single specialty; it requires the co-operation of pediatrician, surgeon, radiologist, and tumor therapist. In the period of several decades covered by the survey, policies in handling of patients have changed as newer technics of therapy have developed.

Total Surgical Excision: Complete extirpation of the tumor (when there are no demonstrable metastases) is without doubt the treatment of choice. In 24 cases, there was what was thought to be complete surgical excision of the mass. In all but 3 of these, x-ray irradiation was given over the operative site, in the belief that this might destroy any remaining bit of tumor too small to be seen by the surgeon. [Details of the x-ray treatment have been described by Wittenborg in Radiology **54:** 679, 1950.] All 24 patients have been followed for two or more years; there have been only 3 deaths, a cure rate of 88 per cent. [It is extremely rare for recurrence or metastasis to appear in a patient who is in good health two years after treatment; patients who are well at the end of two years and who have no evidence of neoplasm by physical examination or by roentgen examination of chest and skeleton are considered cured.]

Partial Excision Plus X-Ray Therapy: In 22 instances the great bulk of the tumor was excised, but it was quite obvious that much tumor tissue had been

left in the field. These patients were then treated postoperatively with x-radiation to the remaining tumor (more recently, some have also received tumor chemotherapy). Of the 22 so treated, 14 were well and free of disease for two or more years, a cure rate of 64 per cent.

Biopsy and X-Ray Therapy: Twenty-four patients received x-irradiation after biopsy only. There are 9 long-term survivors in this group, a cure rate of 38 per cent. A comparison of this figure with the 64 per cent for the previous group, in which most of the tumor was excised prior to irradiation, indicates that surgical removal of the great bulk of a tumor prior to radiotherapy improves the probability of cure. These figures indicate also that in those patients for whom it is possible only to obtain a biopsy (because of poor general condition or the great extent of the neoplasm), a fair salvage rate can still be expected with irradiation.

Biopsy Only: Prior to adoption of x-ray therapy as part of the treatment of neuroblastoma (about 1937), 20 patients had only biopsy and were not given any definitive therapy; all of this group were inoperable. Two infants whose condition was regarded as hopeless because of widespread and nonremovable neoplasm are now well and completely free of disease twenty and twenty-five years later. Presumably, the very cellular and rapidly expanding tumor grew beyond its blood supply, then degenerated and disappeared.

Tumor Chemotherapy: Definite regressions of skeletal metastases from neuroblastomas have followed chemotherapy in some instances, and temporary healing has been found in a few. Impressive changes clearly give a bright hope that in the future significant improvements in treatment for neuroblastoma will come from chemotherapeutic attacks.

Metastases: Metastases to bone, demonstrable roentgenographically or identifiable by bone-marrow biopsy, are indicative of a fatal outcome within a matter of months. Of 74 patients presenting bone metastases when first seen, only 1 survives. Pulmonary metastases were present in 20 patients, 19 of whom are now dead. There were bone metastases, also, in 15 of the 20 patients in this group. Neuroblastoma with metastases to the liver (even though these are massive in the liver) is curable in the majority of instances. In 9 infants in whom the tumor originated in the adrenals or in the retroperitoneal structures, surgery disclosed extensive liver metastases but roentgen examination showed no skeletal involvement. Treatment consisted of x-irradiation. One patient died of aplastic anemia a year later, and 2 died of disseminated neuroblastoma. The remaining 6 are living and well with no evidence of neoplasm from five to fifteen years later, a cure rate of 67 per cent. All 6 of these infants were under one year of age at the time of treatment.

From 1920 to 1930, neuroblastoma was regarded as a hopeless disease; no effort was made to treat the condition, and there were no cures. About 1930, surgical attempts at excision came into vogue, and in a few years surgical excision was combined with x-ray therapy to offer some hope. The cure rates for the decades 1930 to 1940 and 1940 to 1950 were 23.8 per cent and 22.1 per cent, respectively. From 1950, the addition of chemotherapy to the therapeutic armamentarium has resulted in a rise in the cure rate for neuroblastoma to 36.7 per cent of all patients entering the hospital, regardless of age or the extent of the neoplasm. For babies under a year of age, the cure rate in this last period was 56 per cent; if there were no demonstrable metastases to bone at the time of hospitalization, the cure rate was 70 per cent.

Twelve figures.

Carcinoma in Situ of the Cervix: A Clinical Review of 842 Cases. Elizabeth Mussey and Edward H. Soule. Am. J. Obst. & Gynec. **77:** 957–972, May 1959. (Mayo Clinic and Mayo Foundation, Rochester, Minn.)

The authors review 842 cases of carcinoma *in situ* of the cervix in which the diagnosis was made and treatment carried out at the Mayo Clinic from January 1, 1932, through December 31, 1957. From 1932 through 1940 only 9 cases were seen; from 1941 through 1950 the incidence was approximately 18 cases per year; beginning in 1951, following institution of the policy of making a cytologic study on every patient over thirty years of age, the yearly incidence rapidly increased to 155 cases in 1957.

Hysterectomy (vaginal, total abdominal, or Wertheim) was the treatment in 747 cases. The removal of a non-invasive lesion of the cervix was accomplished by hysterectomy and excision of a cuff of the upper part of the vagina. Of great prognostic value was the presence of carcinoma *in situ* in the removed vaginal cuff; in 3 such patients carcinoma subsequently developed in the vaginal vault.

More conservative procedures were employed in patients less than thirty-five years of age who manifested a desire for pregnancy. There were specific indications for therapeutic conization or a radium application in a dose of 3,000 mg. hr. in these instances. The importance of periodic re-examinations after treatment was emphasized to the patient.

Follow-up data were available on 561 cases. Six patients were known to have subsequent carcinoma of the vaginal vault. However, no carcinoma developed in the 40 patients treated with radium or radium and x-rays.

Five figures; 8 tables. ROBERT L. EGAN, M.D.
University of Texas, Houston

Cortisone and X-ray Treatment of Hand-Schüller-Christian's Syndrome. Jørgen Røjel and Viggo Lund. Acta med. scandinav. **161:** 459–462, 1958. (County and Town Hospital, Skive, Denmark)

A review of the literature disclosed several reports of the successful treatment of Hand-Schüller-Christian syndrome with roentgen rays (see, for example, Childs and Kennedy: Radiology **57:** 653, 1951). ACTH and cortisone have also been used in a number of cases, but no record could be found of protracted cortisone treatment.

The authors present the case of a six-year-old boy who was treated for three years by cortisone and small doses of x-rays (a total of 50 r × 14). The patient's physical development has been normal, and intelligence is somewhat above average. Regression of the cranial lesions has been demonstrated by serial roentgenographic studies. A left-sided exophthalmos has almost subsided. No signs of diabetes insipidus have developed.

Although treatment appears to have been successful in the authors' case, they believe a reserved attitude should be adopted in the evaluation of such measures

in conditions like Hand-Schüller-Christian syndrome, in which spontaneous cures have occasionally been observed.

Four roentgenograms.

The Energy and Quantum Equivalent of the Röntgen. T. Mulvey and J. Ballinger. Brit. J. Radiol. **32:** 408–410, June 1959. (Associated Electrical Industries, Ltd., Aldermaston, Berkshire, England)

To relate ionization measurements to the energy content of an x-ray beam one must know the average energy, W, required to form a pair of ions in air, and the fraction of the incident x-ray quanta that produces ionization. W appears to be largely independent of the energy or the nature of the ionizing agent. A value of 33.0 eV is used in the present calculations. The efficiency of transfer, however, depends on the x-ray wave length, and on this point calculations of various authors are not in good agreement. Differences can be ascribed to the use of different values for the photoelectric absorption coefficient. The discrepancies can be largely removed if a correction for coherent scattering is applied to data obtained by experiment.

The energy density per roentgen and the quantum equivalent of the roentgen are given, as a function of wave length.

Three graphs; 2 tables. LUCILLE A. DU SAULT
The Henry Ford Hospital

RADIOISOTOPES

Radioiodine Therapy of Hyperthyroidism. Glenn E. Sheline and Earl R. Miller. Arch. Int. Med. **103:** 924–932, June 1959. (University of California School of Medicine, San Francisco, Calif.)

The authors describe their experience with radioiodine therapy of hyperthyroidism. Four hundred thirty-one patients with thyrotoxicosis were treated. Of these, 29 had toxic nodular goiter; 78 had postsurgical recurrent toxic goiter, and 324 had toxic diffuse goiter. In 95 per cent toxicity was controlled with radioiodine; therapy in the other 5 per cent was incomplete. Thyrotoxicity was controlled in 59 per cent by one treatment; 61 per cent became euthyroid within three months.

Hypothyroidism developed in 17 per cent of the 309 patients treated for toxic diffuse goiter, and 3 per cent had recurrences. When hypothyroidism occurred, it was usually seen within a few months, but in 1 case it did not appear until the sixth year after therapy.

Exophthalmos may improve, appear, or progress after radioiodine therapy. Although comparison is difficult, it would appear that in this respect the results are about the same or slightly better than after surgical subtotal thyroidectomy. Orbital decompression became necessary in one patient, but in no case was vision lost.

There was one unexplained death three weeks after treatment with I^{131}. In 3 patients under twenty years of age thyroid nodules developed five or more years after therapy.

Eleven tables. THEODORE E. KEATS, M.D.
University of Missouri

Daily Variations in the Thyroidal Uptake of I^{131} in Human Subjects. Richard P. Levy, Patricia Caughey, and David Turell. J. Clin. Endocrinol. **19:** 632–637, June 1959. (Western Reserve University, Cleveland, Ohio)

Forty-nine euthyroid subjects were studied on two successive days to evaluate the constancy of thyroidal I^{131} uptake. The thyroidal uptake of I^{131} and the urinary excretion of iodide (I^{127}) were measured three and twenty-four hours after administration of I^{131} tracers. Six patients had day-to-day changes in twenty-four-hour I^{131} uptake of more than 10 per cent of the administered tracer; 3 had variations of three-hour I^{131} uptake of more than 6 per cent. No correlation between the variability of the thyroidal uptake of I^{131} and the amount of iodide excreted was found when the daily excretion was less than 500 μg.; when more than this amount was excreted, variability in thyroidal I^{131} uptake from one day to the next was no longer encountered. Thus, when an apparent discrepancy between the clinical picture and the thyroidal uptake of I^{131} is observed, day-to-day variation of this index of thyroid function should be considered among the possible causes of such a finding.

Two graphs. AUTHORS' ABSTRACT

Iodine Metabolism in Goitrous Cretins. John U. Gardner, Alvin B. Hayles, Lewis B. Woolner, and Charles A. Owen, Jr. J. Clin. Endocrinol. **19:** 638–657, June 1959. (Mayo Clinic, Rochester, Minn.)

The iodine metabolism of 6 sporadic goitrous cretins was studied by determination of stable and radioactive iodine. The 6 patients were placed in three groups on the basis of the level and type of metabolic block in the chain of events leading to the elaboration of thyroid hormone. The 3 patients in Group I were able to trap iodide without being able to bind it to protein, although in 1 patient minute amounts of monoiodotyrosine were found in the thyroid gland. The 2 patients in Group 2 could trap iodide and totally bind it to protein, but the resulting iodotyrosines were converted to only a small amount of thyroxine. Radioiodinated tyrosines were present in the serum and urine of these 2 patients. The single patient in Group 3 was able to trap iodide but, unlike those in Group 2, could bind only part of it to protein. The resulting thyroidal iodotyrosines were associated with only a small amount of thyroxine in the thyroid gland and with iodotyrosines in the urine.

Ten figures; 5 tables. AUTHORS' ABSTRACT

Thyroid I^{131} Content of Victorian Lambs in Relation to Nuclear Weapon Tests. Lester Van Middlesworth and Roger Melick. M. J. Australia **1:** 664–666, May 16, 1959. (R. M., University of Melbourne, Melbourne, Victoria, Australia)

The radioactive iodine content of the thyroid glands of sheep from Victoria, Australia, was evaluated over a sixteen-month period, beginning with April 1957, in an effort to determine the effects of nuclear weapons tests. No radioactivity was found at the beginning of the observation period but after Christmas Island explosions 4,400 miles away (May 15 and 31) a slight but definite increase in the radioactive content of the glands was observed. The Maralinga tests, 1,000 miles away caused an easily detectable amount of I^{131} in the thyroid

glands of lambs for a time; three months after the last of these tests no radioactivity was detectable in the thyroid glands.

The Victorian figures were compared with those from Tennessee for sheep and cattle. When the Victorian activity was low, there was still appreciable activity in the northern hemisphere. This suggests that the northern atmosphere did not mix freely with the southern, that the mixing was so slow that the iodine activity originating in the northern hemisphere had decayed below detectable levels, or that all I^{131} had been deposited before the northern atmosphere reached Australia.

This study was felt to be a sensitive test of fission products from nuclear reactions and provides information about iodine metabolism and the movement of air masses. The data, however, give no direct information on other fission products. Also, sheep and cattle thyroid glands collect much more radioactivity than human thyroids. Studies on different animals suggest that ingestion is the major source of I^{131}, while man probably gets most of his I^{131} from inhalation. Human autopsy glands examined in Australia and in Tennessee contained little or no activity.

Earlier studies on sheep (Bustad *et al.*: Radiation Res. **6:** 380, 1957. Abst. in Radiology **70:** 151, 1958) suggest that 100 mμc per gram for life would produce no known biological effects; the maximum observed in the present project was 17.8 mμc per gram, with an average peak of 8.67 mμc per gram. These levels may be compared with those attained in the human thyroid after I^{131} tracer tests. With a 40 per cent uptake of I^{131} after a 20 μc dose, and a 50-gram thyroid, the thyroid will contain about 160 mμc per gram. For simplicity, the decay of the isotope is ignored in this calculation.

Two graphs.

Percutaneous Implantation of Radiogold into the Hypophysis of Patients with Metastasizing Mammary or Prostatic Carcinoma. E. Frey and U. Cocchi. Schweiz. med. Wchnschr. **89:** 652–656, June 20, 1959. (In German) (Röntgendiagnostische Zentralinstitut der Universität Zürich, Zürich, Switzerland)

In an effort to reduce the severe pains caused by skeletal metastases, the authors implanted Au^{198} into the hypophysis of 8 patients: 7 women with metastatic breast cancer and a man with metastatic carcinoma of the prostate.

The procedure was well tolerated even by patients with far advanced cancer. Puncture of the sella turcica was performed by the percutaneous, paranasal, transethmoidal, transsphenoidal route. The hollow needle employed for the injection had a pointed mandrin for advancing it and 3 blunt stilets of different lengths for the introduction of the radiogold seeds, each containing 10 mc of Au^{198}. Four radiogold seeds were implanted in every patient of the series, with the exception of 1 woman with a small sella, in whom only 3 seeds were placed.

No deaths resulted from the treatment. Pain was reduced in every instance and in 2 cases practically disappeared. Metastases in the bones were arrested but not those in the liver and lungs.

The authors' clinical and histologic studies proved it impossible to destroy the whole pituitary body by central implanation of 40 mc of Au^{198} in 4 seeds.

Three roentgenograms; 2 photomicrographs; 1 photograph; 2 tables.

Radioactive Fat Absorption and Clinical Response of Sprue to Steroid Therapy. Report of Three Unusual Cases. Charles H. Brown, Otto Glasser, and Edward J. Kurt. Gastroenterology **36:** 760–769, June 1959. (Cleveland Clinic, Cleveland, Ohio)

In many cases of sprue the typical symptoms and signs of the disorder may not be present, its complications may dominate the picture, and the diagnosis may be difficult. Radioactive fat studies of such patients can be of help, since a specific absorption pattern of radioactive fats and fatty acids can be observed in different types of malabsorption syndromes.

Kaplan *et al.* (Gastroenterology **34:** 901, 1958. Abst. in Radiology **72:** 470, 1959) showed that the previously flat I^{131}-tagged triolein absorption curve of a patient with sprue became normal during steroid therapy, which also induced clinical remission. This and other studies indicate that steroids may have a specific effect on intestinal absorption, particularly of fats.

Three unusual cases are presented. Each patient had diarrhea and low serum albumin and was malnourished. Radiographic studies of the small intestine showed a disordered motility pattern and deficiency state. Two patients had hypocalcemia, tetany, and osteoporosis. Two had edema, and one had bleeding associated with increased prothrombin time.

I^{131}-tagged triolein and I^{131}-tagged oleic acid were given per os to all of the patients, and samples of blood were taken at two, four, six, and eight hours after the test meal to measure radioactive fat content. The curves were "flat," showing poor absorption for all three patients. None responded to standard treatment. Steroid therapy resulted in great clinical improvement, paralleled by an increase in the absorption of fat.

Determination of the uptake of radioactive triolein and oleic acid is a simple, dependable means of measuring fat absorption and can be of aid not only in the diagnosis of sprue but also in determining the response to treatment.

Four roentgenograms; 7 photographs; 2 charts.

ZOLTAN SZALONTAY, M.D.
Mercy Hospital, Pittsburgh

Pathogenesis of Anemia in a Case of Nontropical Sprue. Study Made Using Radioactively Labeled Vitamin B_{12} and Radiochromium. E. Richard Ensrud, Eric E. Wollaeger, Joseph M. Kiely, and Charles A. Owen, Jr. Gastroenterology **36:** 812–815, June 1959. (Mayo Clinic, Rochester, Minn.)

In a case of nontropical sprue the outstanding clinical manifestations were diarrhea, anemia, and skeletal pain secondary to osteomalacia. The patient had experienced occasional irregular episodes of rectal and vaginal bleeding for the past six years. Hematologic studies revealed hypochromic microcytic anemia. The radioactive vitamin B_{12} tracer test given either alone or with intrinsic factor showed greatly decreased absorption of vitamin B_{12}. Chromium-51-labeled erythrocytes showed normal survival time. The daily stool examination revealed an average daily blood loss of 17.3 ml. The depletion of iron evidenced by hypochromic anemia was demonstrated to be due at least partly to gastrointestinal bleeding and partly to deficient iron absorption, which is common in idiopathic steatorrhea.

Vitamin B_{12} therapy plus the parenteral administration of iron produced a satisfactory reticulocyte response and apparently helped to maintain a hematologic

remission originally established with the aid of blood transfusion.

Two charts. ZOLTAN SZALONTAY, M.D.
Mercy Hospital, Pittsburgh

Bronchogenic Carcinoma from Radioactive Cerium Fluoride. Herman Cember, Joseph A. Watson, and Albert A. Spritzer. Arch. Indust. Health **19:** 14–23, January 1959. (Department of Occupational Health, University of Pittsburgh, Pittsburgh, Penna.)

Rats were exposed, by intratracheal insufflation, to radioactive cerium fluoride ($Ce^{144}F_3$), at dose levels of 0 (nonradioactive CeF_3 control), 5, 15, 25, and 50 μc per rat. Bronchogenic carcinoma was observed in all groups of exposed rats; the frequency in each group was $^1/_{27}$, $^1/_{23}$, $^7/_{28}$, and $^4/_{15}$. The smallest tumorigenic dose was 2,400 rad. The National Bureau of Standards *Handbook 52* (*Maximum Permissible Amounts of Radioisotopes in Air and Water*) lists 7×10^{-9} μc/ml. as the maximum allowable concentration of radioactive cerium in the atmosphere. Extrapolation of the results of the present investigation to air-borne Ce^{144} suggests that the maximum permissible atmospheric concentration of this isotope is too high, and that consideration should be given to a more conservative figure.

Two autoradiographs; 6 photomicrographs.

RADIATION EFFECTS; PROTECTION; RADIOBIOLOGY

Common Sense in the Diagnostic Use of X-Ray. Jarrell E. Miller and Gerald E. Swindell. J.A.M.A. **170:** 761–765, June 13, 1959. (3500 Gaston Ave., Dallas 10, Texas)

As a result of recent publicity concerning the hazards of radiation, there has developed a questioning attitude among patients regarding dangers inherent in exposure to x-rays for medical diagnosis. The benefits of x-ray examinations, on the other hand, have received little public notice.

The amount of exposure to ionizing radiation during diagnostic radiography was studied in a number of hospital patients. Measurements made on a wax phantom gave dosages of radiation in milliroentgens per film received by the skin and gonads during various examinations. These figures were compared with corresponding measurements made on patients during examinations of the urinary bladder and during pelvimetry. Agreement was sufficiently close to justify the use of the phantom for studying radiation exposure rates. The authors emphasize the distinction between local exposure and total-body irradiation, between irradiation of the gonads and the rest of the body, and between somatic and genetic effects.

The hazard of radiation exposure from average x-ray diagnostic procedures is insignificant compared with the danger of practicing medicine without roentgenology.

Two tables. WILLIAM MARTEL, M.D.
University Hospital, Ann Arbor, Mich.

Radiation Dosage to Female Gonads During Diagnostic Roentgenographic Procedures. George Cooper, Jr., and Kenneth Williams. J.A.M.A. **170:** 766–769, June 13, 1959. (University of Virginia Hospital, Charlottesville, Va.)

The exact genetic effect of a given x-ray dosage is not known for man. Since it must be assumed that any dose of radiation, however small, can cause cumulative genetic damage, gonadal exposure is particularly important.

With the use of simple shields, male gonads can be well protected from significant exposure. The position of the ovaries protects them from scattered radiation but requires that they be in, or close to, the direct beam during a number of diagnostic procedures. Using a cadaver, the authors determined the ovarian dosage during various diagnostic procedures. Careful attention to technic of examination, selection of equipment, proper collimation, and adequate shielding where possible, will reduce ovarian dosage. Only the most essential x-ray examinations should be performed during pregnancy.

The authors include a table showing the number of various diagnostic x-ray examinations involving significant ovarian dosages performed at their institution in 1957 and indicate the age distribution.

Three tables. WILLIAM MARTEL, M.D.
University Hospital, Ann Arbor, Mich.

Accidental Radiation Dermatitis. Acute Reaction to Roentgen Rays. Colvin H. Agnew. Texas State J. Med. **55:** 292–295, April 1959. (Department of Radiology, University of Texas Medical Branch, Galveston, Texas)

The author reports 2 cases of serious accidental radiation dermatitis, in a surgeon and patient, incurred from the employment of fluoroscopy for localization of a foreign body. The frequency of exposure played a part in this accident. The surgeon had the unique experience of using the procedure on 2 patients within a two-week interval. The first patient examined required little treatment; the second patient and the surgeon have required continuous observation and local treatment. About one week after fluoroscopy, the skin of the second patient and the surgeon became erythematous, and finally a wet reaction developed. About six months after exposure, the lesions were excised and skin grafting was carried out successfully.

Sometime after the examination the author determined the output of the x-ray machine by placing a Victoreen 100-r chamber in the approximate position of the surgeon's hand, about 10 cm. from the face of the tube housing. There was no nearby scattering material. The average of several determinations was 180 r per minute (air). There was no way to regulate beam size. There were no filters, though it was stated that filters had been present at the time of the accident but had been removed by a repair man.

The steps which should be taken to reduce the risk from fluoroscopy are reiterated.

Six photographs.

Long-Delayed Bowel Complications of Radiotherapy. W. J. Simpson and W. B. Spaulding. Canad. M. A. J. **80:** 810–812, May 15, 1959. (W. B. S., University of Toronto, Toronto, Ont., Canada)

It is well known that intestinal obstruction and fistula formation may be late complications of radiotherapy without any associated evidence of recurrent neo-

plasm. The authors describe a case which appeared fourteen years after radiation therapy.

A thirty-four-year-old patient had a subtotal hysterectomy and partial bowel resection for a tumor of the uterus adherent to the bowel. Fifteen years later, in 1938, she experienced vaginal bleeding, and in 1940 an epidermoid carcinoma of the cervix was discovered which infiltrated the upper two-thirds of the vaginal wall. She was treated with high-voltage (400-kv) therapy, receiving 2,400 r to each side of the pelvis anteriorly, 1,800 r to the right side posteriorly, 1,500 r to the left side, and 2,400 r intravaginally, followed by intravaginal radium (4,200 mg. hours). She felt well for fourteen years, after which time an entero-vesical fistula developed. The diagnosis was confirmed at operation and a fistula was also discovered between two adherent portions of the ileum. Following surgical repair, the patient made a good recovery. Microscopic study of the resected portion of the ileum showed chronic inflammatory changes such as may follow long after irradiation, but no evidence of carcinoma, tuberculosis, or Crohn's disease.

Two other cases of long-delayed bowel complications of radiotherapy are briefly summarized: In one of these a vesicovaginal fistula developed four years after irradiation. In the other there was hemorrhage from multiple ulcers of the small and large bowel, attributed to radiation fibrosis.

One diagram. ZOLTAN SZALONTAY, M.D.
Mercy Hospital, Pittsburgh

Fetal Exposure to Diagnostic X-Rays, and Leukemia and Other Malignant Diseases in Childhood. Dorothy D. Ford, J. C. S. Paterson, and W. L. Treuting. J. Nat. Cancer Inst. **22:** 1093–1104, June 1959. (Tulane University, New Orleans, La.)

A survey of the comparative incidence of exposure to antenatal irradiation *in utero* and of leukemia and other malignant diseases in later childhood is reported. The study was based upon deaths from these causes, before the age of ten years, in Louisiana, during the five-year period 1951–55. The control series comprised deaths from other causes matched for age, sex, race, and place of death. Information concerning the incidence of irradiation (diagnostic x-ray examination during the last trimester of pregnancy) was obtained from professional sources, either from the doctor who delivered the mother or from the institution in which the child was born.

The incidence of x-ray exposure was found to be as follows: leukemia cases, 26.9 per cent; malignant disease cases, 28.4 per cent; control cases, 18.3 per cent. These findings are in substantial agreement with those of Stewart *et al.*, in England (Brit. M. J. **1:** 1495, 1958. Abst. in Radiology **72:** 634, 1959). The findings lend emphasis to the need for minimizing exposure of the fetus to x-rays by careful determination of the indications for antenatal radiography and by attention to the technical procedures.

Eight tables. SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

Rupture of the Common Carotid Artery Following Radical Neck Surgery in Radiated Cases. Julius W. McCall, C. W. Whitaker, and E. L. Hendershot. Arch. Otolaryng. **69:** 431–434, April 1959. (2060 E. 9th St., Cleveland 16, Ohio)

The hazards of radical neck surgery following radiation therapy are discussed with emphasis on carotid artery complications. Since the carotid artery derives 80 per cent of its blood supply from its adventitia, and the adventitia is removed in the course of radical neck dissection, the artery is dependent upon the skin flaps for its future nourishment. Irradiated tissues with their decreased vascularity do not heal well after surgery, and no other region is more in need of an adequate vascular supply than the tissues of the neck. Failure of the flaps to heal predisposes to oral and pharyngeal fistulas and necrosis and rupture of the common carotid artery. While flap necrosis and fistulas can be treated with deliberation, rupture of the common carotid is a dire emergency demanding immediate attention. Four cases of common carotid rupture are reported; in these cases ligation of the artery was performed with no neurological sequelae.

The authors believe that adequate surgery should be the treatment of choice for cancer of the head and neck, while irradiation should be reserved for surgically inaccessible neoplasms and for palliation. In irradiated cases, a pedicle flap should be raised at the time of dissection, and, if necessary, the irradiated skin should be sacrificed with the specimen.

Two photographs.

Effects of Total-Body Irradiation on the Production of Antibody in Man. Irwin L. Stoloff, Farid I. Haurani, Evalyn F. Repplinger, and W. Paul Havens, Jr. New England J. Med. **260:** 1258–1261, June 18, 1959. (Jefferson Medical College, Philadelphia, Penna.)

The capacity of 7 Schick-negative patients with acute leukemia or disseminated neuroblastoma to respond to a booster dose of diphtheria toxoid after varying doses of radiation and infusion of human bone marrow was determined. Exposure to amounts of radiation ranging from 170 to 490 r apparently did not significantly alter either the qualitative or the quantitative response in 5 patients. It is possible that a dosage of 800 r delayed or suppressed the production of antibody, although the data are too meager to cite in support of this. Attempts to demonstrate the transfer of antibody-producing cells from donors to recipients, as manifested by measurable increases in circulating tetanus antitoxin in the recipients, were unsuccessful.

Two figures; 1 table.

Irradiation Effects on Malignant Cells in Smears from Oral Cancers. A Preliminary Report. William Umiker, Isadore Lampe, Robert Rapp, Howard Latourette, and Delbert Boblitt. Cancer **12:** 614–619, May–June 1959. (I. L., University Hospital, Ann Arbor, Mich.)

Smears were obtained from the surfaces of 32 oral carcinomas of various sites prior to, during, and after completion of radiation therapy. The follow-up periods ranged from four to twenty months, with a mean of ten months.

The cytological expression of radiation effects on malignant cells reflects: (1) accentuation of the unaltered morphology of the individual neoplasms; (2) degeneration or complete destruction; (3) maturation; and (4) in about 50 per cent of the cases, a temporary decrease in cohesiveness of the malignant tissue.

Malignant cells were present in the oral smears at the completion of irradiation in the majority of oral carcinomas, but sometimes disappeared after treatment. No cytological conversions were observed after the eighth week from the time of institution of irradiation.

Destruction of malignant cells by irradiation appears to be much more important than does radiation-induced tumor differentiation.

Increased exfoliation of malignant cells was found in one-half the cases, between the ninth and eighteenth days of treatment, probably due to increased cohesiveness of the neoplastic tissue rather than to stimulation by irradiation.

Abundant exfoliation of carcinoma cells may indicate an increased likelihood of metastases.

Seven photomicrographs; 1 graph.

Relative Effectiveness of Testicular Shielding in Diagnostic Radiology. P. M. Bretland. Acta radiol. 51: 465–472, June 1959. (University College Hospital, London, England)

The author of the present investigation discusses special devices made of plastic lead-containing fabric which were constructed for experimental purposes and compared with two simple lead shields in current use for testicular protection.

One device described is a 0.5-mm.-lead-equivalent lead-rubber strip designed solely to shield from the primary beam. A second device made of lead containing plastic fabric and in an open-box-type arrangement is designed to shield against scattered radiation also. A third device is somewhat similar but has additional upper flexible flaps to shield against the scatter from the pelvis.

Measurements were made with an air-wall ionization chamber of about 40 c.c. volume. Most of the work was done on cadavers after autopsy. Measurements were made over the 53 to 95-kv range, simulating radiographic conditions at 40 inches focus-to-film distance and fluoroscopic conditions with 20 inches focus-to-skin distance.

Under ordinary radiographic conditions the closed box gave the best protection by far; the open box was no better than the lead flat-type shield, presumably due to scatter entering the top from the pelvis. The protective effect on the thighs alone was demonstrated to be surprisingly good (9 to 13 per cent), and addition of the lead-rubber strip kept the dosage well below 0.5 per cent. With no added protection outside the primary beam, the dosage did not exceed 0.25 per cent. The results were similar under fluoroscopic conditions.

Whereas the estimated dose from an anteroposterior roentgenogram of the pelvis at 65 kv is approximately 1,100 milliroentgens to the testicles, the lead rubber strip would reduce this to about 3 milliroentgens and the "Plastoled" closed box to less than 1 milliroentgen.

Perhaps the most interesting and surprising finding is that in the postero-anterior projection (by contrast with the anteroposterior projection) there is an absorption in soft tissue of the low-energy radiation and considerable protection is afforded the testicles by absorption in the thigh.

One figure; 2 tables. I. MESCHAN, M.D.
Bowman Gray School of Medicine

Recovery from a Single Dose of X-Ray in Old and Young Rats. John B. Hursh and George W. Casarett. Am. J. Physiol. 196: 649–652, March 1959. (Department of Radiation Biology, University of Rochester, Rochester, N. Y.)

The recovery from the stress produced by a large dose of x-rays was compared in 546-day-old and 107-day-old rats. The animals were given a large single dose of whole-body x-irradiation followed by a test dose at an interval of two, five, and eight days. Mortality in thirty days was measured and recovery from the first dose was calculated.

The preliminary expectation that old rats might recover more slowly was based on the common observation that injuries such as broken bones and superficial wounds heal more slowly in aged individuals. Analysis of the results of the present investigation, however, showed that, after a single dose of x-rays, residual injury was repaired in old rats at a rate no less rapid than in young rats.

Four figures; 1 table.

Late Effects of Total-Body Roentgen Irradiation. V. Longevity and Incidence of Nephrosclerosis as Influenced by Partial-Body Shielding. Baldwin G. Lamson, Marta S. Billings, and Leslie R. Bennett. J. Nat. Cancer Inst. 22: 1059–1075, June 1959. (School of Medicine, University of California, Los Angeles, Calif.)

After receiving 1,000 r, hypoxic, total- or partial-body irradiation, 242 female Wistar rats were observed throughout their lifespan. Hypoxic irradiation with superimposed anesthesia resulted in 67 per cent, 30-day mortality. Selection of the colony by acute postirradiation deaths did not influence the magnitude of late radiation sequelae as measured by life-shortening. Growth retardation during the second post-irradiation year was well correlated with life-shortening. Life-shortening was observed after partial-body irradiation to an extent approximately proportional to the weight of irradiated tissue. Nephrosclerosis was not observed unless the upper abdomen was included within the radiation field. Except for nephrosclerosis, a similar incidence of disease was observed at death in control and partial- or total-body irradiated rats.

Four figures; 6 tables. SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

Effects of Prenatal X-Irradiation on Testicular Function and Morphology in the Rat. Benjamin H. Ershoff. Am. J. Physiol. 196: 896–898, April 1959. (Western Biological Laboratories, Culver City, Calif.)

An investigation was undertaken to determine the comparative effects of a single sublethal dose of x-irradiation administered at various stages of prenatal development on testicular function and morphology in the rat. Fifty female rats of the Long-Evans strain, three to four months of age and with an average body weight of 188 gm., were divided at random into five equal groups of 10 rats each and were mated to males of proved fertility. Pregnancy was dated from the time that sperms were actually observed in the vaginal smear. Animals in Group I served as nonirradiated controls. Those in Groups II, III, and IV received a single exposure of 150 r x-irradiation on the tenth, fourteenth, or eighteenth day of pregnancy, respectively. Animals in Group V received a single exposure of 300 r on the eighteenth day of pregnancy.

The findings confirm and extend previous observations that x-irradiation during certain stages of prenatal development results in testicular injury and infertility in the male rat. The effects were particularly marked in the offspring of rats irradiated on the eighteenth day of pregnancy. These rats showed, in addition to testicular injury, a significant reduction in seminal vesicle

weight. Testicular injury also occurred in the offspring of rats irradiated on the fourteenth day of pregnancy but was less marked than in the eighteen-day series. No abnormalities in testicular function or morphology were found in the offspring of rats irradiated on the tenth day of pregnancy.

Five photomicrographs; 1 table.

Hormonal Factors Influencing Postirradiation Creatinuria and Polyuria in the Rat. G. M. Krise and C. M. Williams. Am. J. Physiol. **196:** 1352–1355, June 1959. (C. M. W., Radioisotope Laboratory, VA Hospital, Pittsburgh, Penna.)

During the first twenty-four hours after 1,500 r of whole-body irradiation, fasted rats experience a polydipsia and polyuria which is approximately four to five times normal. This phenomenon can be inhibited by the antidiuretic hormone vasopressin (Pitressin) injected intramuscularly in oil either immediately before or immediately after irradiation. Creatinuria also occurs immediately following whole-body irradiation with the initial excretion peak on the second postirradiation day. Since it has been shown that postirradiation diuresis in rats is dependent upon the presence of the adrenal cortex, the authors considered it pertinent to examine the excretion of creatine by adrenalectomized rats after irradiation and to investigate the relationship between creatine excretion and urine volume in irradiated rats injected with Pitressin. Postirradiation creatinuria and polyuria were also examined in thyroparathyroidectomized animals.

Normal albino rats exposed to 1,500 r of whole-body Co^{60} gamma radiation were found to have a significant increase in urinary creatine excretion for the first three days postirradiation. Adrenalectomized rats, irradiated at eight days postoperatively, did not show a creatinuria significantly greater than nonirradiated controls. Thyroparathyroidectomized rats, irradiated at eight days postoperatively, did not have a significant increase in urinary creatine excretion over that of nonirradiated fasted controls. There were no significant increases in polyuria or polydipsia on the first postirradiation day in either the adrenalectomized or thyroparathyroidectomized rats. The intramuscular injection of 500 MU of Pitressin in oil inhibited post-irradiation polydipsia and polyuria in normal rats but increased significantly the urinary excretion of creatine over that of irradiated noninjected controls.

Two tables.

Influence of Cysteine on the Intestinal Epithelium of X-Irradiated Rats. Robert P. Beliles, James G. Kereiakes, and Adolph T. Krebs. J. Nat. Cancer Inst. **22:** 1045–1057, June 1959. (U. S. Army Medical Research Laboratory, Fort Knox, Ky.)

Cysteine reduced the degree of x-ray-induced mitotic inhibition of the epithelial cells in the small intestine of rats exposed to 100 r and 300 r whole-body irradiation. For a 300 r dose level, the rate of recovery of the mitotic activity of the cysteine-treated animals was approximately the same as for those which were untreated. The time required for recovery of the mitotic activity varied with the radiation dose. A disappearance of crypt structure in the higher dose range, 1,000 r and 3,000 r, was noted. The protective effect of cysteine on crypt structure was reflected by increased survival in rats pretreated with cysteine at 1,000 r. For 3,000 r, some protection by cysteine was indicated in early mitotic-activity observations and in a slight increase in the survival time.

Seven photomicrographs; 2 graphs; 4 tables.

SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

Delayed Physiologic and Morphologic Changes of the Peripheral Nerves Following Massive Irradiation. E. Linder. Fortschr. a. d. Geb. d. Röntgenstrahlen **90:** 618–624, May 1959. (In German) (Röntgeninstitut der Universität und des Inselspitals, Bern, Switzerland)

The immediate effect of irradiation of peripheral nerves has been studied by several workers. It is known that doses of about 100,000 r are needed to produce acute damage of the isolated peripheral nerve. The author has studied the late effect of irradiation of peripheral nerves in white rats. The left sciatic nerve was irradiated with 3 × 1,000 r in two days. The right sciatic nerve was covered with lead and used as a control. The rats were killed three to eleven months after irradiation. Action potentials and histologic preparations of the nerves were studied.

No alterations in irritability, course, form, or speed of conduction of action potentials were demonstrated. In 25 per cent of the irradiated nerves, localized morphologic changes, consisting of degeneration of nerve fibers and fibrous tissue reaction leading to scarring, were shown. In spite of these morphologic changes in the nerves, no functional alterations were observed. This is explained by the smallness of the lesions. The localized type of tissue reaction indicates an indirect pathogenic mechanism, and the author favors the hypothesis of primary changes in the small vessels. Small vessels are known to be sensitive to relatively small radiation doses.

Seven figures.

ERIK CARLSSON, M.D.
Edward Mallinckrodt Institute of Radiology,
St. Louis, Mo.

Stimulation of Cholesterol Biosynthesis from Acetate in Rat Liver and Adrenals by Whole Body X-Irradiation. R. Gordon Gould, Virginia L. Bell, and Edith H. Lilly (with the technical assistance of Patricia Keegan, Jean Van Riper, and Mary Lou Jonnard). Am. J. Physiol. **196:** 1231–1237, June 1959. (Los Alamos Scientific Laboratory, Los Alamos, N. M.)

Earlier studies have shown a large increase in the rate of biosynthesis of cholesterol in rat liver and adrenals in intact animals two days after whole-body irradiation. The present authors have investigated this finding more extensively and under a variety of conditions; they also attempted to determine, by use of tritium-labeled body water, if changes in the incorporation of acetate-1-C^{14} into cholesterol in intact animals is a reliable index of changes in the rate of cholesterol biosynthesis. Guinea-pigs, mice, rats, and rabbits were used in the experiments.

Whole-body x-irradiation resulted in an increased cholesterol biosynthesis in rat liver and adrenal glands, as measured by the rate of incorporation of either acetate-1-C^{14} or H^3 OH in intact animals. The effect was significant twenty-four hours postirradiation but was much larger at forty-eight hours, and was proportional to dosage over the range 300–2,400 r. In liver the increase in rate was about 100 per cent/100 r. Intestine showed no effect and carcass only a slight increase. Mice showed a small increase in hepatic cholesterol biosynthesis but rabbits and guinea-pigs no significant

change. Both acetate-1-C^{14} and H^3OH gave reasonably constant ratios of C^{14} and H^3 in liver and carcass cholesterol in control and irradiated rats, supporting the hypothesis that the use of acetate-1-C^{14} in whole animals under standard conditions, is a reliable measure of cholesterol biosynthetic rate. The proximate cause of the increased rate of cholesterol synthesis is postulated to be the decreased concentration; in liver a decrease of 0.12 mg./gm. was correlated with a doubling of the synthetic rate.

Four graphs; 7 tables.

Gamma Irradiation on Rat Whole Blood Cholinesterase. Martin W. Williams. Am. J. Physiol. **196:** 949–950, May 1959. (University of Vermont College of Medicine, Burlington, Vt.)

Whole blood cholinesterase levels in rats were followed electrometrically for ten days following whole-body irradiation with 300 and 600 r gamma rays from a Co^{60} source. Cholinesterase activity was significantly depressed in both groups after the third day, reaching its lowest observed levels on the tenth day. The toxicity of acetylcholine bromide was significantly greater for mice nine days after 300 r of whole-body gamma irradiation than in nonirradiated controls, as indicated by the intraperitoneal LD 50, which was 294 mg./kg. prior to, and 235 mg./kg. after, irradiation.

One graph.

Nuclear Propulsion. Cataractogenic Effects from Fast Neutrons. John E. Pickering and D. V. L. Brown. Texas State J. Med. **55:** 264–266, April 1959. (J. E. P., School of Aviation Medicine, Randolph Air Force Base, Texas)

In an effort to determine the effects of ionizing radiation on man, 24 two-to-three-year-old small male Primates (*Macaca mulatta*) were exposed to 14-Mev neutrons. The animals were divided into four dose groups —0, 75, 250, and 850 rep. During exposure, they were positioned, three at a time, around the stainless steel target of a Cockroft-Walton generator so that the target distance was 10 cm. from the center of the sphere to the zygoma at the outer canthus.

Monkeys receiving 850 rep showed immediate post-irradiation changes of conjunctival and retinal vasodilatation, subconjunctival hemorrhages, papilledema, retinal edema, and occasionally vasospasm. Subsequently total desquamation and epilation occurred. By the sixth month twenty to forty very small, round, white vacuole-like opacities confined to the posterior subcapsular area were observed in the lenses of 3 animals in this group. Lymphedema or corneal changes precluded examination in 2 of the remaining animals, and the third displayed massive, relatively recent bilateral anterior chamber hemorrhages with hyphema. At fourteen months the anterior subcapsular area showed 200 to 300 small scattered granules and a similar number of vacuoles of various sizes. The posterior subcapsular opacities were relatively unchanged, although the clumps of opacities were more numerous and covered more of the capsular area.

Animals receiving 250 rep of fast neutrons underwent similar but much less severe early post-irradiation changes. True epilation did not occur, nor did desquamation. Lens opacities were first observed in the twelfth month following radiation and affected the anterior and posterior subcapsular areas simultaneously. Twenty-six months after exposure, there were more than 100 anterior subcapsular opacities with some tendency to accumulate in the axis. Posterior subcapsular vacuoles and granules numbered several hundred and showed further lateral spreading with an increase in density of the axial mass.

Only mild immediate changes occurred in the animals exposed to 75 rep of fast neutrons. At twenty-four hours a slight transient skin reddening was apparent, with minimal conjunctival and retinal vasodilatation. No cellular reaction in the anterior chamber was seen. Several animals showed suspicious changes in the anterior and posterior subcapsular areas at thirteen months following irradiation. It is thought to be improbable that these will progress to the more characteristic radiation changes.

The authors conclude that fast neutrons are more effective in producing lens abnormalities than roentgen rays, gamma rays, and/or thermal neutrons. In fast-neutron exposures resulting from the operation of a nuclear propulsion system, the neutron damage to the lens of the eye is not the limiting factor. The doses required to produce a mature cataract are of sufficient magnitude that other radiation effects of more serious consequence will precede the incapacitating effects of mature cataract. As a matter of fact, it appears that the localized neutron dose necessary to produce significant numbers of opacities is greater than, or certainly approaches, if administered to the whole body, the radiation dose considered to be the ID 30/50 for man.

Three tables.

Protective Effect of Artificially Induced 'Hibernation' Against Lethal Doses of Whole Body X-Irradiation in CF_1 Male Mice. Sondra M. Kuskin, S. C. Wang, and Roberts Rugh. Am. J. Physiol. **196:** 1211–1213, June 1959. (College of Physicians and Surgeons, Columbia University, New York 32, N. Y.)

The purpose of the present investigation was to ascertain the protective effect of "lytic cocktails" (a mixture of drugs having central depressant properties) and refrigeration, alone or in combination, in CF_1 mice exposed to a lethal dose of whole-body x-irradiation (700 r). The drugs employed were Hydergine, chloropromazine HCl, promethazine HCl, urethane, and reserpine. Control animals received physiological saline solution. After the intraperitoneal injection of one of the drugs, or a "lytic cocktail," about half of the mice were kept at normal room temperature for ten to sixty minutes before irradiation, while the other half were placed in a freezer (−10° C.) until the rectal temperature had dropped to between 20 and 23° C., which usually took twenty to sixty minutes.

Regardless of the drug administered, the hypothermia produced in animals which had been refrigerated immediately prior to irradiation caused a significant improvement in their chances of survival. The overall survival rate was 43.3 per cent, in contrast to 7.9 per cent of survival in the group of mice treated with the same drugs but kept at room temperature. That refrigeration, and not the drug administered, is the most important factor in increasing survival is indicated by the fact that in the refrigerated groups, the differences in survival rate between the controls (which received no pretreatment with drugs) and those groups which were pretreated with drugs were not statistically significant. Nevertheless, when the controls were grouped with those receiving Hydergine, chlorpromazine, or promethazine, the survival percentage was significantly higher than

that of the remaining groups treated with urethane, Hydergine mixture, chlorpromazine mixture, or reserpine.

At room temperature, promethazine or urethane do not afford any protection against irradiation, whereas the other drugs afford only a slight degree of protection, probably related to a small drop in body temperature.

One table.

A Study of Comparative Protection against Lethality of Triethylenemelamine, Nitrogen Mustard, and X-Irradiation in Mice. Edwin I. Goldenthal, M. V. Nadkarni, and Paul K. Smith. Radiation Res. **10:** 571–583, May 1959. (E. I. G., Division of Pharmacology, Food and Drug Administration, Department of Health, Education, and Welfare, Washington, D. C.)

A comparison was made of the protective action of cysteine, cysteamine, and sodium nitrite in mice on the toxicity of nitrogen mustard (HN2), triethylenemelamine (TEM), and x-irradiation. An attempt is made to explain the results of these experiments in terms of the chemical reaction between the alkylating drugs and the protective compounds.

Striking differences were revealed in the degree of protection obtained by the preadministration of the compounds. All compounds afforded some protection against the lethal effects of irradiation. Substantial protection against the lethality of HN2 was obtained with cysteine, and some protection with cysteamine. None of the compounds gave measurable protection against TEM.

Chemical interaction of HN2 or TEM with cysteine or cysteamine *in vitro* was demonstrated. The reaction of HN2 with cysteine or cysteamine was instantaneous, whereas that between TEM and cysteine or cysteamine required several hours. It is suggested that the difference in reactivity may explain the differences in the degree of protection afforded by the sulfhydryl-containing compounds.

The *in vitro* reaction product of TEM with cysteine was isolated and purified. Its probable structure is suggested. This compound was found to be inert with respect to toxicity as well as carcinostatic effects on leukemia-1210.

A threefold increase in the urinary excretion occurred when cysteine was preadministered to mice as compared to HN2 alone. Mice pretreated with cysteine before HN2 administration excreted a new compound in the urine; this has been shown to be the reaction product of the two compounds. The suggestion is made that the mechanism of cysteine protection is through direct chemical inactivation of HN2.

Four figures; 8 tables.

Modification of Radiation Injury in Rats Through Gastrointestinal Tract Shielding and Bone Marrow Therapy. S. Tom Taketa, Marguerite N. Swift, and Victor P. Bond. Am. J. Physiol. **196:** 987–992, May 1959. (U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.)

The efficacy of postexposure administration of isologous bone marrow in preventing mortality was compared in whole-body x-irradiated rats and in animals exposed with three grossly different amounts of the gastrointestinal tract exteriorized and lead shielded. Survival was not enhanced by the treatment in animals which sustained severe intestinal radiation injury and died during the first postexposure week. Significant protection was afforded, however, in animals in which the incidence of acute intestinal radiation deaths was reduced or virtually eliminated by intestinal shielding, and deaths in the untreated controls occurred predominantly during the second postexposure week from bone-marrow injury. The data demonstrate that bone-marrow therapy is effective primarily in preventing deaths associated with radiation-induced damage to the hematopoietic tissue and not to the intestine. Hence its therapeutic value becomes limited as the prominence of intestinal injury increases with increasing radiation dosage in the whole-body irradiated animal.

Four graphs; 2 tables.

Attenuation of Roentgen Radiation in Lead at 70 to 1400 kV. R. Thoraeus. Acta radiol. **51:** 473–478, June 1959. (Karolinska Sjukhuset, Stockholm, Sweden)

The author reports on the experimental determination of attenuation factors for six tube voltages from 70 to 170 kv. Plane lead absorbers were used with six field diameters from about 10 to 70 cm. A comparison of the attenuation at minimum field size, narrow beam, with those at maximum field size, broad beam, showed a considerable difference. Particular attention is drawn to the percentage increase of the lead thickness required to reduce the broad-beam attenuation to the same value as the narrow-beam attenuation. For each tube voltage, this value was almost independent of the lead absorber thickness; hence, averages are reported. The values are reported in terms of the broad-beam factor, t_2/t_1, which is the factor by which the lead thickness obtained by the narrow-beam attenuation must be multiplied in order to obtain the lead thickness which gives the same numerical value of the broad-beam attenuation.

The author has also compiled published broad-beam and narrow-beam attenuations. These include the data of Miller and Kennedy (Radiology **65:** 920, 1955) for the 275 to 52-kv range and Wyckoff, Kennedy, and Bradford (J. Res. Nat. Bureau Standards **41:** 223, 1948) for the 500- to 1,400-kv range in lead. The author has calculated the broad-beam factor (t_2/t_1) from the above articles and illustrated these graphically with his values from 70 to 170 kv. The factor t_2/t_1 slowly increases up to 100 kv, may be considered constant and equal to 1.10 in the region of 100 to 450 kv, again begins to increase at about 500 kv, reaching a value of about 1.20 at 1,000 kv and 1.25 at 1,400 kv. These ratios are of value in computing shielding requirements, since the narrow-beam attenuation is in general easier to measure experimentally.

The author also discusses briefly the question of limiting the motion of the therapy tube and protecting the upper walls and ceiling against secondary radiation. He reports that many architects and radiologists feel that this technic of protection impairs the applicability of the installation, with a relatively small saving.

Two diagrams; 2 tables. RICHARD L. WITCOFSKI
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Specification of Radiation Quality. Harald H. Rossi. Radiation Res. **10:** 522–531, May 1959. (Radiological Research Laboratory, Columbia University, New York 32, N. Y.)

Radiation quality has been commonly expressed in terms of the linear energy transfer (LET) of the ionizing particles that deliver the absorbed dose. The detailed mechanism of energy loss of charged particles is such

that there is a very complex relation between LET and the energy deposited in some small region of the irradiated tissue. The author discusses the limitations of the concept of LET distribution of dose and proposes an alternate parameter, Y, that may be used to express radiation quality.

Y is defined as the energy imparted to a small sphere divided by the sphere diameter. Representation of the dose in Y for a range of diameters yields information on the spatial distribution of energy, as well as on the local dose and the frequency with which such a dose is delivered. It is believed that this representation may prove useful in fundamental radiobiological and radiochemical studies.

Determination of the Quality of the Absorbed Dose Delivered by Monoenergetic Neutrons. W. Rosenzweig and H. H. Rossi. Radiation Res. **10:** 532–544, May 1959. (H. H. R., Radiological Research Laboratory, Columbia University, New York 32, N. Y.)

The authors have made a study of the pulse-height spectra and resultant dose distributions for monoenergetic neutrons as a function of neutron energy and also sample size. The neutrons were produced at a Van de Graaff generator at the following energies: 0.2, 0.5, 1.0, 2.0, 3.0, and 4.0 Mev by the tritium (p, n) reaction; 6.0 and 8.0 Mev by the deuterium (d, n) reaction. For the thickness of target employed, it was estimated that the spread of neutron energies was ± 30 per cent at 0.2 Mev, ± 15 per cent at 0.5 Mev, ± 10 per cent at 1.0 Mev, and ± 5 per cent or less at the higher energies. Two 4-inch spherical proportional counters were used with the electrode structures as described elsewhere (Radiation Res. **2:** 417, 1955. Abst. in Radiology **66:** 802, 1956). One had a tissue-equivalent conducting plastic wall (TE counter) and the other was identical with the first except that it had a $^1/_{32}$-inch aluminum liner on the inner surface (Al counter). The TE counter can be considered to be equivalent to a spherical biological structure surrounded by tissue; the Al counter is equivalent to the same structure but completely isolated. Whereas the former will record recoil protons which originate both within and without the sphere, the latter will record only those which arise from within. Pulse-height spectra were obtained at all energies with the TE counter. The Al counter was used at each pressure only for those energies which yielded an appreciable gas contribution. The results of the measurements are presented.

It is felt that the radiobiologist performing neutron irradiations can benefit greatly from interpreting the results of his own experiments in light of the findings reported in this paper. It must be borne in mind that, if the variation in the parameters LET or Y (see preceding abstract) are responsible for corresponding variations in the relative biological effectiveness (RBE) of radiation, then the RBE of neutrons is inextricably related to the neutron energy. Existing discrepancies in the RBE of "fast" neutrons may be attributable to failure to take this variation into account. It must be noted further that on a microscopic level, particularly at low neutron energies, the picture depends greatly on the size of the biological structure under consideration. The two factors which enter here are the local hydrogen content which affects the magnitude of the total absorbed dose and the actual physical size compared to the range of the recoil protons, which affects the detailed energy deposition as illustrated by the dose *versus* Y curves.

Twelve graphs; 1 table.